THE Petroleum Engineer

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• Drilling and Producing • Refining and Petrochemical • Oil and Gas Pipelining

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The Theme Is Conservation

Oil Progress Week this year (October 11-17) has as its theme conservation. The theme is well chosen. All progress basically is aimed at conservation, whether it be proper methods of producing a field to assure maximum ultimate recovery, the use of the best refining methods to obtain greatest product yield from each barrel of crude oil, or the most efficient and therefore most economical method of transportation.

"True conservation," it is pointed out by a spokesman for the American Petroleum Institute, sponsors of Oil Progress Week, "means getting the most out of everything we withdraw from nature's wonderful warehouse, using it wisely and at the same time providing for the future." This is in sharp contrast to the view of the uninformed who think of conservation as hoarding.

Knowing that oil is irreplaceable, oil men for years have been doing their utmost to carry out these dictates. The result has been the saving of hundreds of millions of barrels of oil that otherwise might have been lost forever.

The fact that the spotlight is being turned on conservation doesn't mean that it is something new. The State of Texas was first to recognize the need for conservation measures, when in 1899 it was legislated that natural gas should not be allowed to escape into the air nor burned in flares. Conservation practices had been adopted in many states by 1924, and in 1935 the Interstate Oil Compact Commission was formed to advance the cause of conservation.

Oil men need not be told what these conservation practices are: Scientifically spacing of wells, water flooding and repressuring with water and/or gas, producing well at most efficient rates of flow, pressure maintenance — the list is long.

More than half of the oil wells drilled in this country since 1859 are still producing due to such recovery measures. It is estimated that 4 billion barrels of oil may be obtained from known fields by secondary recovery methods, and that 107 billion barrels are susceptible to the application of these methods.

To develop new techniques, new processes, and to improve old ones, $130,000,000 was spent last year alone on research. These many things add up to assurance that America will have sufficient oil to meet all requirements in the foreseeable future.

Conservation and progress truly are synonymous!

The Meaning of Three Letters

On the title pages of numerous leading publications throughout the country are displayed these three letters — ABC. They mean Audit Bureau of Circulations. This organization semi-annually audits the circulation lists of member publications, one of which is The Petroleum Engineer.

The significance of being permitted to display the ABC emblem lies in the fact that it is a mark of good faith — good faith with advertisers and good faith with readers. By opening its records to auditors of the Bureau a publication establishes the honesty of its circulation figures. Of equal importance, in our opinion, is the guarantee membership in ABC carries to the reader, signifying as it does that the primary objective is to give him what he wants. To meet ABC standards all subscriptions must be paid. If a subscriber's requirements are not fulfilled he need not, and does not, renew his subscription. The decision is entirely his. That's how simple it works. When a publication stops serving its readers it stops having readers, and ABC is the medium whereby these facts are made known.

— F.H.L.

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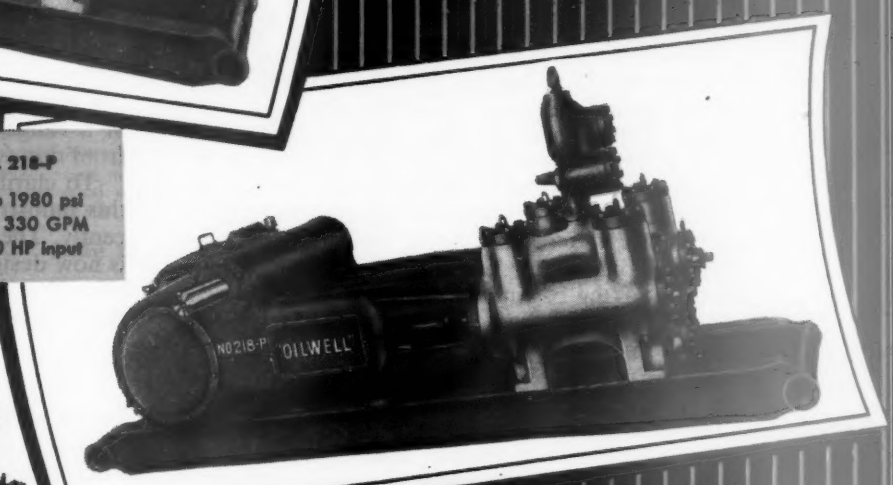

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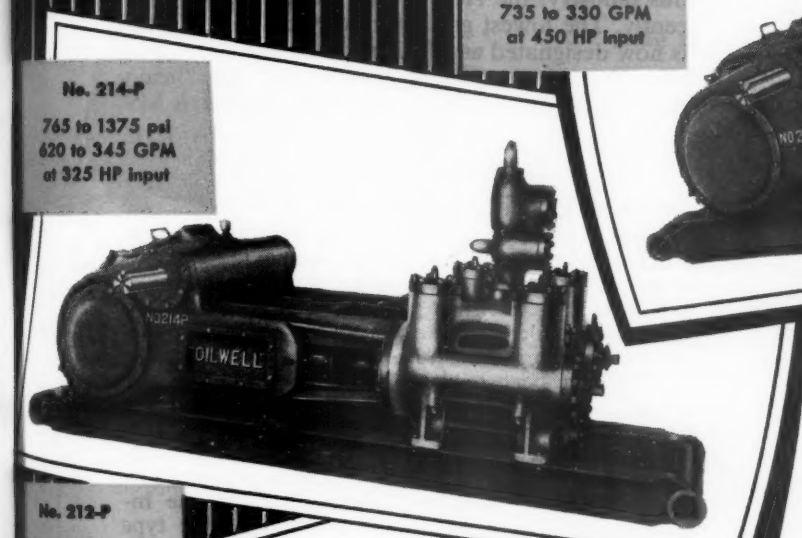

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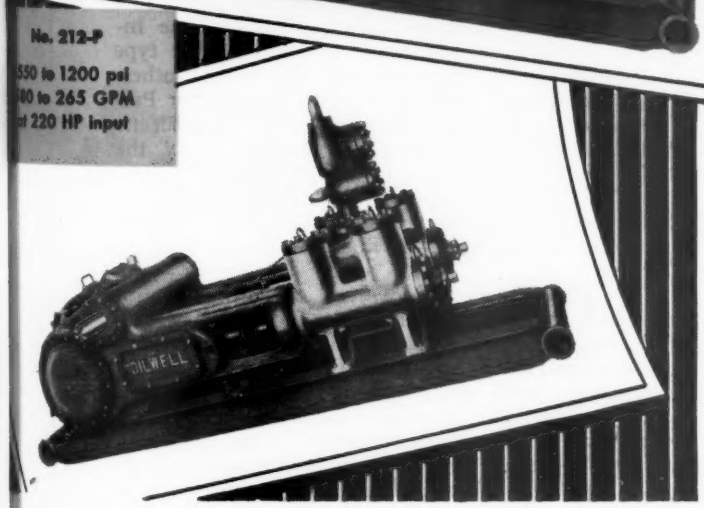

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1953

XUM

With the EDITORS

"Assembled" Lubricating Oils!

Nearly a quarter-century back, the writer — reckless amateur! — made the statement in public print to the effect that the "Motor Oil of Tomorrow" would be assembled, in the sense that a goodly number of component parts would eventually be combined into the finished product, each component adding its own special property to the mix to yield a super-product. Although we have not yet quite reached the goal referred to we are approaching it so closely that that term may be applied safely to the greater portion of our present output of lubricating oils.

Outstanding among the components used in blending today's motor oils are classified under the general term "additives." Earlier such words as "gunk", "mousemilk" and less complimentary (also less printable) terms were used to describe or to castigate the non-petroleum materials added to lubricants in efforts to improve various properties. Often times the results varied from identical to horrible, from no change at all in properties to the point of making bad matters worse. A rapidly advancing technology has systematized both research methods and knowledge now possessed until the motor oils of today have standards of performance that straight mineral oil products can never attain.

The industry now uses detergent additives; dispersants; oxidation-corrosion inhibitors; extreme pressure additives; pour-point and viscosity index "improvers", anti-rust agents, and any number of other addition agents. In each of these categories one or more agents have been developed that increase the property indicated well beyond any natural product's capabilities. We are mindful of the family of Para products brought out by the Esso people; the extreme pressure and other additives of the Lubrizol line, all of which have seen applications in varying degrees to solve innumerable problems.

Not only do we have the chemical addition agents but various synthetic hydrocarbon oils, mostly of non-petroleum, and all of direct synthetic origin, have been developed; typical of this group is the Prestone-designated synthetic lubricating oil brought out some years ago, pioneered by Carbide and Carbon Chemicals, an oil with so high a viscosity index — ratio between temperature and viscosity changes — that additives for this purpose are not required. In cases the high VI Prestone oils may be blended with a natural petroleum fraction to better its own viscosity up to competitive levels.

Huge amounts of money have been spent to develop these oils and the additives used, and to show the superior performance of the reinforced oils. "No Wear" claims such as Continental Oil's are backed by a large amount of road research. Postponement of the time for overhaul is one strong claim, extending the period between overhauls by 2½ times being claimed for very heavy-duty engines. A large cab company found 40,000 miles to be the interval when cabs were operated on "a good grade of regular oil", more than 100,000 miles when run on the newer type of heavily-fortified oils.

And sales have risen by leaps and bounds. In the Mid-1940's lube makers are said to have bought $25 million worth of additives; for 1953 the estimated consumption is $100 million worth. Boosting the price from 25-35 cents for non-additive oils up to 45 cents — as much as $1 for Prestone oil — per quart at the service station appears to have been no insurmountable obstacle to rapidly increased sales. One of the most outstanding products to be developed lately is the jet engine lubricant that enables the engine to function properly at a range of more than 400 Fahrenheit degrees from minus 150 to 250 F above zero.

To clarify and standardize the nomenclature of this industry, the API revised the terminology recently. The lowest grade formerly called "regular" is now designated as ML type; the second or "premium" grade is termed MM, while the "heavy duty" product, for diesels and truck engines, is MS.

— A. L. F.

Economic and Governmental System

Twenty-eight years ago, a progressive supply company gave cause for its slowness in making a remittance in ringing words about the economic and governmental system of that particular time. Their reason is still adaptable today, with a few revisions. Brought up-to-date, it might read like this:

"We have been held up, held down, blasted lambasted, coerced, pleaded with, squeezed and threatened; the government has hit us with income taxes, sales taxes, excise taxes, excess profit taxes, automobile taxes, liquor taxes, equipment taxes and a few thousand more; we have been plagued by the insistence for donations from every conceivable type of organization, club, league, fraternity, lodge brotherhood, and society, ranging from the Society for Prevention of Cruelty to Animals to the Democratic Party, the Republican Party, the Socialist Party, the Red Cross, the Blue Cross, the Double Cross, YMCA and YWCA, Boy Scouts, Girl Scouts and Old Scouts, Relief Society for Upper Slobovia, Relief Society for Lower Slobovia and the Relief Society of Interior Slobovia.

"The government has governed our business until we aren't quite sure who owns it. We are inspected, suspected, examined and re-examined, informed and misinformed, surveyed and purveyed, demanded and commanded, until we aren't quite sure who, why or where we are. We are sure, however, that we are considered an inexhaustible supply of money which can be obtained for every known need, desire or hope of the human or inhuman race. Inasmuch as we have declined to sell what little we still possess to raise funds, and refuse to beg, borrow or steal money to give away, we have since been cussed, discussed, lied to, lied about, held up, robbed, and nearly ruined. The only reason we are clinging to life is to see what is coming next."

D.H.

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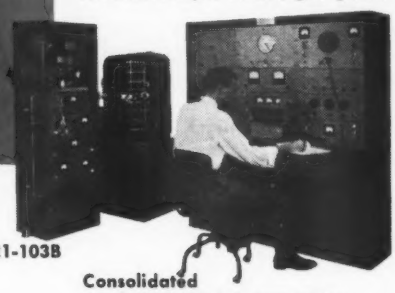

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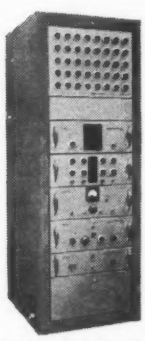

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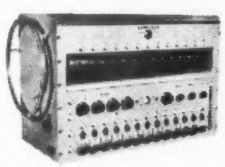

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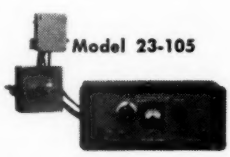

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HIGHLIGHTS IN OILDOM

Texas Oil Output Cut

Texas got its second big cut in oil allowables this month. The Railroad Commission has set its output at 2,904,409 bbl per day, a drop of 86,223 from September. Cutback was brought about by placing the state on a 19-day producing schedule for October, which has 31 days, as against September's 30. The last quarter of the year may bring on a slight recession, Joe Owens, of Sun Oil, reported under questioning by Ernest O. Thompson. Products are not moving as well now as they did in the first half of the year, he added.

Venezuelan Output Down

Carlos Perez de la Cova, minister counselor of petroleum affairs of the Venezuelan embassy in Washington, D. C., said that his country suffered reduced oil output as a result of overproduction of crude oil in the world that has developed this year. Speaking before a meeting of the Interstate Oil Compact Commission, De la Cova reported that "the daily average oil production for June 1953 was 1,749,132 bbl compared to June a year ago of 1,824,642 bbl." He went on to say that daily average of the first six months of 1945 was 1,743,818 bbl, compared to 1,826,483 bbl for the same period of 1952—a decrease of 4.53 per cent.

Special Oklahoma Issue

The December number of The Petroleum Engineer will be a special issue on Oklahoma. As one of the nation's oldest oil states, and third ranking in point of production, this area has had, and continues to have, a colorful background. All phases of operations —drilling, producing, refining, pipelining, exploration, etc.—will be thoroughly covered in articles written by leading men in the industry and staff members.

Control of Atomic Energy

Dr. Hubert Alyea, Princeton University atomic scientist, told members attending National Petroleum Association's 51st annual meeting recently, the story of events leading up to the discovery of atomic energy. He stressed the importance of man's control of this terrific source of energy, and of the problems introduced in this control. Full utilization of atomic energy for peaceful pursuit is not possible until some satisfactory means are developed to assure the entire world it would not be used for destructive purposes, Dr. Alyea told the group.

"The Great Wildcatter" Story of Courageous Adventure

When Mike Benedum completed his home, Greystone, it was one of the finest in Pittsburgh, and one of the luxurious estates of the whole country. The self-reliant wildcatter provided his own water system and its own electric power system.

Mike Benedum also wanted his own natural gas and, to the astonishment of Pittsburgh, moved a derrick into his backyard to go after a gas supply. Sam Mallison, author of "The Great Wildcatter," (Published by Education Foundation of West Virginia, Inc., Charleston, West Virginia. $6.00) says Benedum moved out the rig because of the neighbors' protests; but after reading the adventures of the man who found oil in many states and several foreign countries, the reader can be forgiven for believing that it was also because there was no gas there.

This thick volume (528 pages) is actually a history of the oil industry brought to vivid life by the personal adventures of one of its leaders. Mike Benedum began with a background high in qualities of courage and faith and industry. He developed the successful wildcatter's traits of assurance and decision. He never turned back—from his first discovery in Pennsylvania to the discovery of Big Lake field in Texas, to operations in the Gulf of Mexico. He forgot dry holes and sold or developed production.

Sam Mallison has written a book that oil men will like. Many of them know the people who move through the drama of Mike Benedum's life —Joe Trees, his partner, Paul Benedum, Walter Hallanan, and a hundred others. It is also a book that will give newcomers or outsiders a better picture of the oil industry than any explanation of its operations can ever do because the important part of industry is the people in it and this is the absorbing story of how men worked and traded, fought and went broke, and tried again; it reveals the motives and characteristics of the strong men who laid the basis for the present great petroleum industry.

As a college president said when presenting M. L. Benedum with a doctor's degree: "Your career seems almost unbelievable—if we were to read of it in fiction, we would regard it as too fantastic to be credible."

Oklahoma Builds IOCC Office

Interstate Oil Compact Commission has accepted an offer by the state of Oklahoma to build a new $75,000 office building for use by the commission, rent free, in Oklahoma City. Oklahoma would hold title of the building. Acceptance was voted at the closing session of its summer session in Billings, Montana, recently.

DJ Asks Arkansas to Drop Suit

The Department of Justice has asked Arkansas to drop its oil suit challenging constitutionality of the so-called "tidelands" oil bill. In its suit Arkansas declared the Federal Government holds land and money in trust for all the states and people of the entire country. By giving rights to these oil royalties to coastal states, Arkansas would be deprived of its proportionate share of the money now held by the government, the state argued. The Justice Department told Arkansas it has no legal interest in the money.

Closer Trade Relations With U. S.

Returning from Argentina after traveling 5000 miles by government plane and helicopter on a survey of national resources, J. B. O'Connor, executive vice president of Dresser Industries, Inc., reported the Argentinians are seeking closer trade relations with the United States.

"President Juan Peron, in two long talks I had with him, emphasized his determination to make the nation self-sufficient within a second five-year program just starting," said the widely traveled industrialist. "As a key feature of Argentina's new five-year program of economic expansion, the government will encourage American participation in the development of the country's oil and gas resources."

Deep Well Drilling Ahead

On September 21 at 7 a.m. Ohio Oil Company's KCL A No. 72-4 reached a total depth of 20,927 ft. The well broke the world's depth record on August 20 at 20,521 ft. A feature article on this test begins on page B-55 of this issue of *The Petroleum Engineer*.

Phillips Assets at Billion

An announcement from Bartlesville, Oklahoma, reveals that 36-year-old Phillips Petroleum Company recently became the 30th corporation in American industry with total assets in excess of one billion dollars. Phillips 36-year stretch to the billion dollar level is the shortest time required by any oil company not having predecessor companies with large, integrated operations. Next to the youngest of the 20 largest oil companies, Phillips has grown faster than any of them and faster than any other billion dollar company in last ten years when assets increased fourfold.

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1 Photo showing Peerless Line Separators at Pipeline Station in Oklahoma.

2 Peerless Horizontal Separator handling 240,000,000 cu. ft. per day, while removing condensed liquid from cooling tower, at plant in California.

3 Two Peerless Vertical Scrubbers at a power plant in South Texas, each handling 50,000,000 cu. ft. of gas per day.

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DICK SNEDDON

LONE STAR STATERS INVADE FAR WEST

There recently swept into the Valley of Lost Angels, like a junior hurricane, that inseparable pair of Texans, Ed Trout, vice president of Lufkin Foundry and Machine Company, and Alvin "Dutch" Zwerneman, the Atlas Pipe, Inc., executive from Houston. This duo, wherever they go, can be depended upon to cut more swath than a freshly honed mowing machine. During their brief sojourn in the deep southwest, thus, they jointly hosted a soiree at the Jonathan Club that brought together a rare convocation of top petroleum people.

Incidentally, among the guests, we noted that other illustrious Texan, Bill Kinder, now Garland's No. 1 citizen, whose recent promotion was no surprise to most of us. Despite his apparent youth, the eminent Emsconian practically introduced sucker rods to the petroleum industry and we have been told that when oil prospectors entered the Coalinga area at the turn of the century, their first major discovery was Bill. All that aside, it was a lovely occasion and we had fun hobnobbing with the oil elite of the Pacific under the gracious hosting of these two entertaining gentlemen from the Lone Star State — Ed and Al.

THE REDCOATS ARE COMING

Our San Francisco operative tells us that Jim Gosline, Standard of Cal's assistant general manager of production, will probably be back at Harvard School of Business Administration before this accumulation of trivia hits the newsstands. That makes the third of our acquaintances who have gone to Cambridge, Mass., to acquire a broad "a" and scarlet blazer. Paul Huggins, the Gulf Oil veep, who once introduced us to a delectable concoction, smoked rainbow trout, was the first.

Then followed Roy Johnson, the Republic Supply Company vice president and rathskeller pianist who contributed another infusion of red corpuscles that must have added greatly to the ultimate strength of the Crimson Tide. And now, we shall be watching intently to see the effect of the New England atmosphere and environment on the Gosline comportment and enunciation. The mixture and Harvardian and Santa Paulan ought to be interesting.

WITH A KI-YI-IPPY-IPPI-I

To the capacious and altogether hospitable residence of the Fritz Huntsingers on a recent balmy September evening, came the ladies of the Ventura Desk and Derrick Club with their bosses, in great number and high spirit, and following a lovely season of wassail, they had themselves a real hoedown. The grounds and tables were tastefully decorated in western style, and after a fine barbecued steak diner, served in typical Huntsinger fashion, the girls staged a vaudeville show that was literally out of this world. But more of the thespians anon! For the moment, leave us point out that the head wrangler of this whole affair was Gertrude "Nicky" Nicolini, a capable Shell Oil Company lass who, with an attractive corps of cowgirl assistants, had kept preparations moving in top shape.

In this group were two more Shellites, Shirley Haldeman, in charge of costumes, and Dorothy Nowak, mistress of the dance. From Tide Water were Marjorie Taussig, responsible for the decorations; Frances Sargent, producer of the printed programs; and Jean Hill, the Walter Winchell of the outfit. Intex was represented by Allene McCormick, the musical director, and from the alphabetic MJM&M Company, Leigh Wood did a fine job of taking care of reservations.

OKLAHOMA AGGIE STRUTS HER STUFF

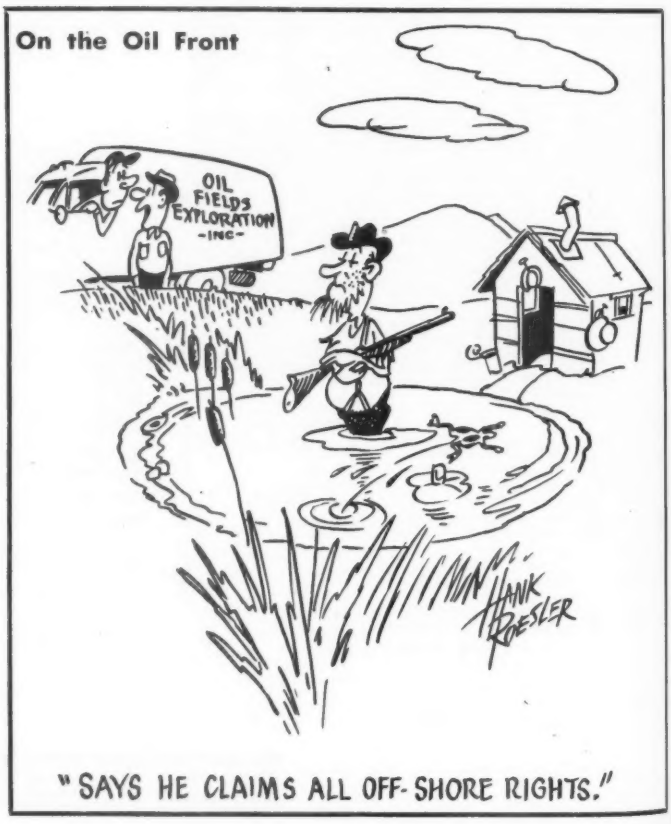
MC'ing the vaudeville show, with all the aplomb of a seasoned performer, was Sunbonnet Sue, GP's Liz Seals, prexy of the local D&D, and if this gal isn't soon grabbed by one of the TV networks, then TV networks don't know what's good for them. On the program were such western notables as Intex's Allene "Calamity Jane" McCormick; Libby Cochran of Halliburton, and Dolores McMunn of B-J Service, the Covered Wagon Gals; Shell's Peggy Weed and Dorothy Nowak, portraying a pair of Pecos people; Gayle "Oklahoma Aggie" Rayson from Tide Water, a thorough professional whose singing has Joe Stafford green with envy; Martha Jamar of J&G Oilwell Service, and Marion Ross of Richfield, the Frontier Gals, who do a sharp simultaneous tap routine; a Shell quartette, the Sarsparilla Sisters, consisting of Peggy Weed, Barbara Peterson, Ruth Williams, and Mary White, the best known receptionist west of the Alleghenies.

Then there was a covey of Swing & Swirl square dancers which included Marceline Bradford of Union Oil Company; Norma Ellsworth, Nina Seibel, Lonnie Fondersmith, Jane Musial, and Dorothy Nowak from the Shell; Maria Porras and Marjorie Reed from the Texas Company; Mary Richardson, Continental; and Leigh Wood, MJM&M.

TOP RANKING TO "THREE-GUN" MILLER

These quadrilateral terpsichoreans went through their intricate measures in fine style guided by Shell's Jack Boucher and his lovely wife and daughter, while the party was practically shot to photographic ribbons by that modest but accomplished young lady from Schlumberger, Jeannette Kastorff. The girls did a wonderful job on this feminine whingding and received generous help from Ventura oil and equipment people as well as from some right substantial townsfolk.

The cow country costumes added greatly to the gaiety of the evening and, incidentally, "Two-Gun" Fred Miller, the Continental higher-up, walked off with the prize for the best western outfit, a toy pistol, and is now known as "Three-Gun" Miller. To the Huntsinger family and their aides, both in and out of the industry, the Ventura D&D girls were voluble in their thanks for sustained interest as well as tangible help. Particularly were they grateful for the use of the beautiful Huntsinger home and grounds, for a fine barbecue dinner, and for a species of hospitality that has made life in the friendly village of Buenaventura a most enjoyable experience.



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Alice, Texas	LaFayette, Louisiana	Plainville, Kansas	Sterling, Colorado
Snyder, Texas	Ruston, Louisiana	Great Bend, Kansas	Casper, Wyoming
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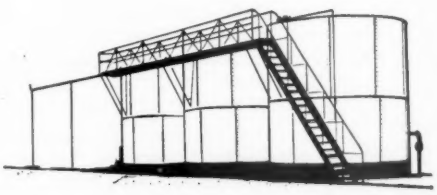

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XUM

BAKER 9X digs slush pit 50′ long, 8′ wide, 54″ deep in 30 MINUTES!

New Baker 9X Bulldozer—with full-capacity blade only 96" wide—permitting portability over the highway—day or night—without special permit.

Designed for fast-down and fast-up action, the revolutionary Baker 9X Dozer is ringing up some impressive records in the oilfields. Typical example is the 9X shown in the photo. Digging slush pits in Wilbarger County, Texas, for an oilfield contractor, this 9X Dozer cut a swath 50′ long, 8′ wide, 54″ deep in *30 minutes . . . in hard, dry ground.*

• • •

The new Baker 9X is the Dozer with the full-capacity blade only 96" wide—constructed as an integral part of the tractor. *See* this completely new idea in bulldozers *in* action! Ask your Baker, A-C Dealer for a demonstration.

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Meetings

Oct. 4-6—**American Association of Oil Well Drilling Contractors,** annual meeting, Denver, Colorado.

Oct. 5-7—**Texas Mid-Continent Oil and Gas Association,** annual meeting, Rice Hotel, Houston, Texas.

Oct. 5-7—**Petroleum Electric Power Association,** 25th anniversary meeting, Hotel Muelbach, Kansas City, Missouri.

Oct. 7-9—**National Association of Corrosion Engineers,** South Central Region annual meeting, Mayo Hotel, Tulsa, Oklahoma.

Oct. 8-9—**California Natural Gasoline Association,** 28th annual fall meeting, Ambassador Hotel, Los Angeles, California.

Oct. 8-9—**Illinois Institute of Technology,** conference on Industrial Hydraulics, annual meeting, Hotel Sheraton, Chicago, Illinois.

Oct. 10—**American Institute of Chemical Engineers,** Oklahoma Statewide All Day Meeting, College High School, Bartlesville, Oklahoma.

Oct. 8-11—**First International Engineers' Congress,** fostered by the Federation Internationale des Associations Nationales d'Ingenieurs, c/o ANIAI, via Terme Diocvleziana, Rome, Italy.

Oct. 11-17—**Oil Progress Week.**

Oct. 12-16—**Cathodic Protection Short Course,** University of Illinois, Urbana.

Oct. 16-18—**New Mexico Geological Society,** annual field conference, El Paso, Texas.

Oct. 19-20—**Independent Petroleum Association of America,** annual meeting, Hotel Texas, Fort Worth, Texas.

Oct. 19-21—**American Institute of Mining and Metallurgical Engineers,** Petroleum Branch fall meeting, Adolphus and Baker Hotels, Dallas, Texas.

Oct. 19-23—**National Safety Council,** annual congress, Conrad Hilton, Congress, Morrison, Hamilton Hotels, Chicago, Illinois.

Oct. 21-23—**Gulf Coast Association of Geological Societies,** annual convention, Captain Shreve Hotel, Shreveport, Louisiana.

Oct.. 22—**American Institute of Chemical Engineers,** Hotel New Yorker, New York, New York.

Oct. 22-23—**Western Petroleum Refiners Association,** regional meeting, Garrett Hotel, Eldorado, Arkansas.

Oct. 22-23—**Natural Gasoline Association of America,** Southern regional meeting, Blackstone Hotel, Tyler, Texas.

Oct. 26-28—**National Lubricating Grease Institute,** annual meeting, Edgewater Beach Hotel, Chicago, Illinois.

Oct. 26-29—**American Gas Association,** annual conference, Kiel Auditorium, St. Louis, Missouri.

Oct. 27—**Association of Consulting Chemists and Chemical Engineers, Inc.,** 25th Anniversary, Hotel Belmont Plaza, New York, New York.

Oct. 27—**Institute of Gas Technology,** annual convention, Chase Hotel, St. Louis, Missouri.

Oct. 28-30—**Technical Conference on Petroleum Production,** Division of Petroleum and Natural Gas, Pennsylvania State College, State College, Pennsylvania.

Oct. 29-31—**Rocky Mountain Oil and Gas Association,** annual convention, Cosmopolitan Hotel, Denver, Colorado.

Nov. 2-4—**American Petroleum Credit Association,** 29th annual conference, Biltmore Hotel, New York, New York.

Nov. 2-6—**Society of Automotive Engineers,** National meeting, Conrad Hilton Hotel, Chicago, Illinois.

Nov. 2-6—**American Institute of Electrical Engineers,** fall general meeting, Hotel Muehlbach, Kansas City, Missouri.

Nov. 5-6—**American Association of Petroleum Geologists,** Pacific Section, annual meeting, Hotel Biltmore, Los Angeles, California.

Nov. 9-11—**Geological Society of America,** annual meeting, Royal York Hotel, Toronto, Ontario, Canada.

Nov. 9-12—**American Petroleum Institute,** annual meeting, Conrad Hilton Hotel and Palmer House, Chicago, Illinois.

Nov. 12-13—**Society of Exploration Geophysicists,** midyear meeting, Adolphus Hotel, Dallas, Texas.

Nov. 19—**National Industrial Conference Board,** Schenley Hotel, Pittsburgh, Pennsylvania.

Nov. 19-20—**National Association of Corrosion Engineers,** Western region, fall conference, Biltmore Hotel, Los Angeles, California.

Nov. 20—**Natural Gasoline Association of America,** Panhandle-Plains Regional meeting, Herring Hotel, Amarillo, Texas.

Nov. 29-Dec. 4—**American Society of Mechanical Engineers,** Statler Hotel, New York, New York.

Nov. 30-Dec. 5—**Exposition of Chemical Industries,** 24th biennial run, Commercial Museum and Convention Hall, Philadelphia, Pennsylvania.

Dec. 1-4—**Corrosion Conference,** University of Oklahoma, Norman, Oklahoma.

Dec. 6-8—**Chemical Specialties Manufacturers Association, Inc.,** annual meeting, Mayflower Hotel, Washington, D. C.

Dec. 13-16—**American Institute of Chemical Engineers,** annual meeting, Hotel Jefferson, St. Louis, Missouri.

Dec. 28-29—**American Chemical Society,** Division of Industrial and Engineering Chemistry, 1953 Symposium, University of Michigan, Ann Arbor, Michigan.

1954

Jan. 11-15—**Society of Automotive Engineers,** annual meeting and engineering display, Sheraton-Cadillac and Statler Hotels, Detroit, Michigan.

Jan. 18-20—**Pipe Line Contractors Association,** annual meeting, Shamrock Hotel, Houston, Texas.

NOMADS TO MEET

New York, N. Y., Chapter, First Monday of the Month, Louis Sherry's, New York. Secretary, O. B. Latrobe.

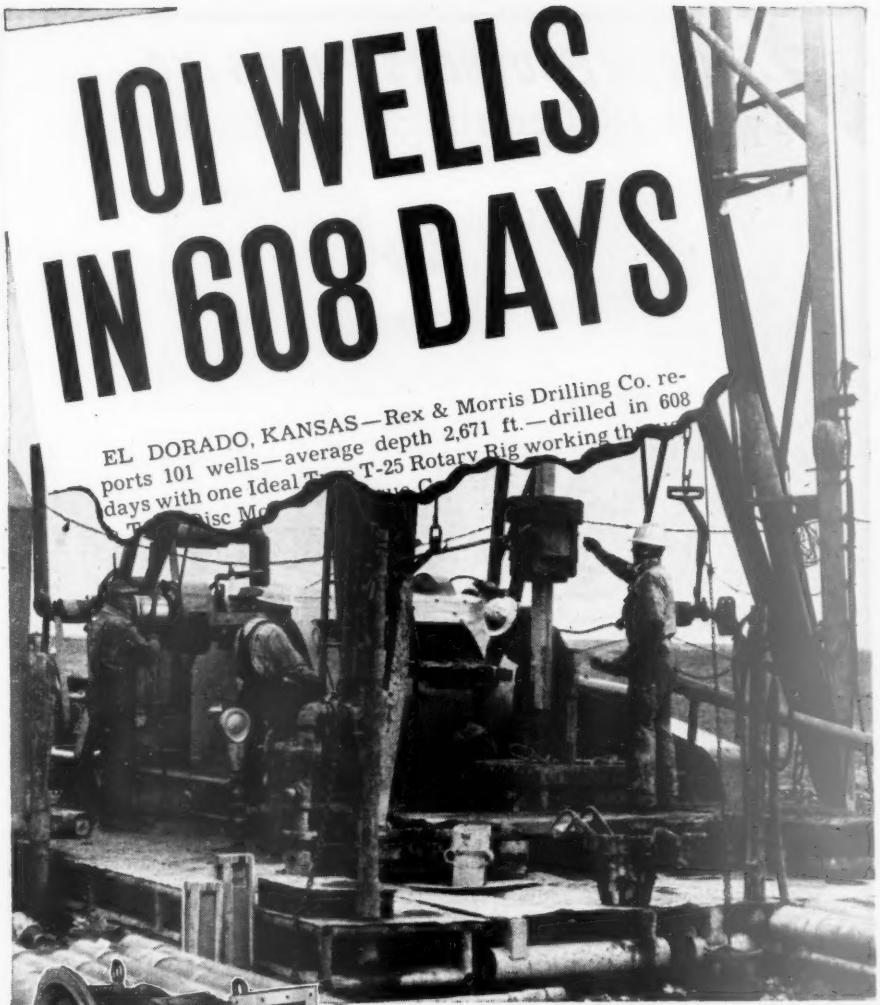
Houston Chapter, Second Monday of the Month, Ye Olde College Inn, Houston, Texas. Secretary, Harry E. Estes.

Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Executive Secretary, Wallace A. Sawdon.

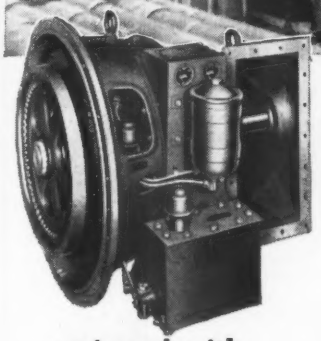
Tulsa Chapter, Third Friday, "After Five" Room, Hotel Tulsa. Secretary, Gilbert Swift.

Dallas-Fort Worth Chapter, Dallas, Texas. First Monday of the Month. Secretary, M. W. Hiltpold.

101 WELLS IN 608 DAYS



EL DORADO, KANSAS—Rex & Morris Drilling Co. reports 101 wells—average depth 2,671 ft.—drilled in 608 days with one Ideal T-25 Rotary Rig working th... Disc M...



equipped with Twin Disc Torque Converter

Model IF Torque Converter on Ideal Rig boosts performance, protects equipment. Independent mounted. Model F (shown above) bolts to engine flywheel for "in-line" mounting. Write for Bulletin 135-D.

Rex & Morris Drilling Co. reports 101 wells—average depth 2,671 ft.—drilled in 608 days with one Ideal Type T-25 Rotary Rig working through a Twin Disc Model IF Torque Converter. All drilling was in hard-formation area in eastern Kansas. Rock bits were used every foot of the way. Original string of drill pipe was used for all 101 wells.

Such record performance is added *proof* that Twin Disc Torque Converters provide extra *boost* needed for *faster, steadier* and *more profitable drilling.* For complete information, write Twin Disc Hydraulic Division.

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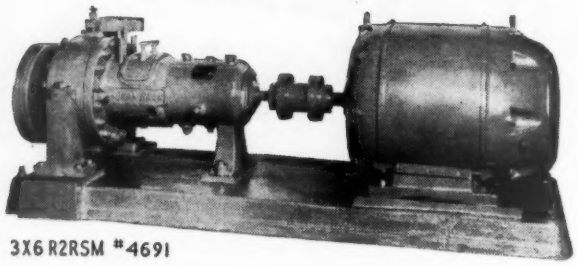
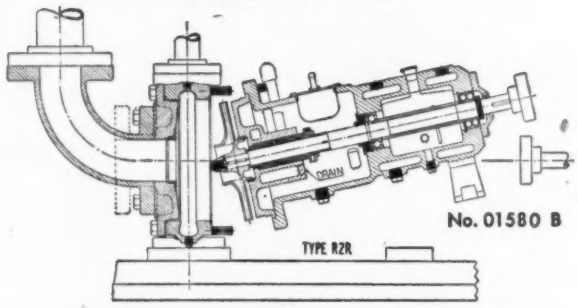
Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute.
Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

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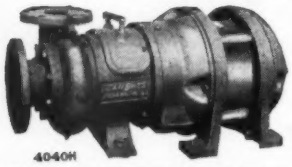
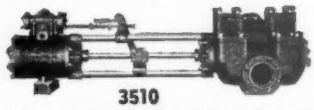
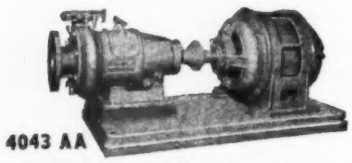


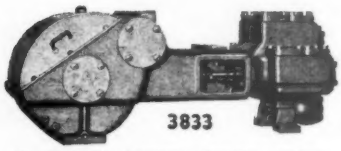
Close Coupled Centrifugal Pump



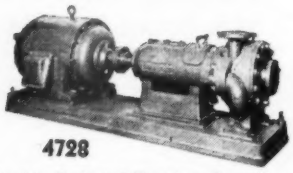
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids



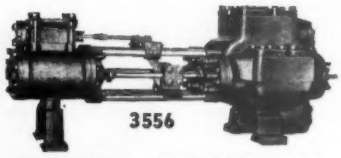
Pedestal Mounted Centrifugal Pump



Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



Double Pedestal Bearing Centrifugal Pump



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Jan. 18-22—**American Institute of Electrical Engineers,** winter general meeting, Statler Hotel, New York, New York.

Jan. 21-22—**American Industrial Conference Board,** Astor Hotel, New York, New York.

Feb. 26—**Natural Gasoline Association of America,** Permian Basin regional meeting, Lincoln Hotel, Odessa, Texas.

March 3-5—**American Petroleum Institute,** Southwestern District, Rice Hotel, Houston, Texas.

March 8-10—**American Institute of Chemical Engineers,** Statler Hotel, Washington, D. C.

March 15-19—**National Association of Corrosion Engineers,** annual meeting, Kansas City Municipal Auditorium, Kansas City, Missouri.

March 17-19—**American Petroleum Institute,** Division of Production, Mid-Continent District, Skirvin Hotel, Oklahoma City, Okla.

March 25—**National Industrial Conference Board,** Ambassador Hotel, Los Angeles, California.

March 25-26—**New England Gas Association,** Statler Hotel, Boston, Massachusetts.

April 8-9—**American Petroleum Institute,** Division of Production, Rocky Mountain District, Townsend, Gladstone and Henning Hotels, Casper, Wyoming.

April 12-15—**Society of Automotive Engineers,** national aeronautics meeting, Statler Hotel, New York, New York.

April 21-23—**Natural Gasoline Association of America,** annual convention, Baker Hotel, Dallas, Texas.

May 2-4—**Independent Petroleum Association of America,** midyear meeting, Cosmopolitan Hotel, Denver, Colorado.

May 3-5—**American Petroleum Institute,** Lubrication Committee, Skytop Lodge, Skytop, Pennsylvania.

May 3-5—**American Geophysical Union,** annual meeting, National Academy of of Science, Washington, D. C.

May 6-7—**American Petroleum Institute,** Pacific Coast District, Division of Production, Statler Hotel, Los Angeles, California.

May 9-12—**Liquefied Petroleum Gas Association,** annual convention, Conrad Hilton Hotel, Chicago, Illinois.

May 10-12—**American Petroleum Institute,** Division of Transportation, Products Pipe Line Conference, Warwick Hotel, Philadelphia, Pennsylvania.

May 10-13—**American Petroleum Institute,** Division of Refining, midyear meeting Rice Hotel, Houston, Texas.

May 10-13—**Liquefied Petroleum Gas Association,** annual convention, Conrad Hilton Hotel, Chicago, Illinois.

May 16-19—**American Institute of Chemical Engineers,** Conrad Hilton Hotel, Chicago, Illinois.

May 31 - June 5—**American Petroleum Institute, Division of Production,** midyear committee conference, St. Francis Hotel, San Francisco, California.

June 17-19—**American Petroleum Institute,** Division of Production, Eastern district, Greenbrier Hotel, White Sulphur Springs, West Virginia.

Sept. 12-16—**American Institute of Chemical Engineers,** Colorado Hotel, Glenwood Springs, Colorado.

Sept. ..... —**Association of Desk and Derrick Clubs of North America,** annual convention, Banff Hotel, Calgary, Canada.

THE Petroleum Engineer
OCTOBER, 1953
P 900.

PETROLEUM INDUSTRY PAUSES FOR APPRAISAL

What is progress and what serves it? The editors of The Petroleum Engineer have found that progress means many things — drilling bits that can penetrate farther and faster, complicated pumping stations that operate automatically, Cinderella molecules, once scorned, which in a change of roles, have turned prosaic refiners into fairy godmothers.

These and other curious and delightful things are progress. Progress is not so much a march, as it is the fruit of the mind — a harvest of ideas carefully gathered and daringly processed into exciting new tools and methods and action.

The oil and gas industry each October measures its progress. Has it served up the energy needed in our expanding civilization? Has it created new products that give comfort and pleasure to modern living? Has it provided for the emergency supply that might mean survival in these explosive times? Has the industry conserved oil and gas to the best of its ability so that coming generations can be served as abundantly as the people of today?

Once each year the petroleum industry takes a look at its recent progress and shines up the best features for public display in what is called "Oil Progress Week."

Because the industry is now so complex that one part of it is only dimly aware of what another branch is doing, *The Petroleum Engineer* editors have spelled out the advances in the various divisions of the industry.

Beginning with exploration that surveys the tidelands with radar and covers both land and sea with a flying magnetometer, and pursuing the appraisal through to the buying power for petroleum products predicted for times ahead, the picture is one that brings with it satisfaction and inspiration. Even the chronic complainer can at least see a glimpse of the greatness of the petroleum industry—its urge to go forward and to grow and at the same time its responsible attitude toward improving its tools and its methods for the most efficient operation, which is the essential element in conserving our resources of oil and natural gas.

This picture is reassuring. In the news about the industry in the general press there is a high percentage of negative headlines. Headlines play up congressional investigations, disagreements in the industry—the "crying" type of news. Closer examination shows the resourceful and successful effort made to lower costs and improve products and service. On the following pages is a report of what the industry is doing and what it hopes to accomplish. The story is fabulous . . .

EXCLUSIVE EXCLUSIVE EXCLUSIVE EXCLUSIVE EXCLUSIVE

Modern Drilling Equipment and Methods . . . . .

SIM H. CREWS

IN 1859, from a total depth of 69 ft, an American oil well began producing at a rate of about 25 bbl a day, precipitating the first oil boom and fathering an industry that has now drilled wells below 20,000 ft and has established a national reserve of over 30 billion barrels of oil. Although hailed as America's first oil well, the Seneca Oil Company completion actually followed by several years the first oil production in this country. Around 1806, in the search for brine, which might be used in the manufacture of table salt, the Ruffner brothers developed the fundamental principal of the cable tool rig near Charleston, West Virginia. Nearly all of the salt wells drilled in that area produced as much as 25 to 30 bbl per day. Although the gas produced with the oil was a valuable aid in the water evaporation, the oil itself provided only a small supplemental income to the salt companies.

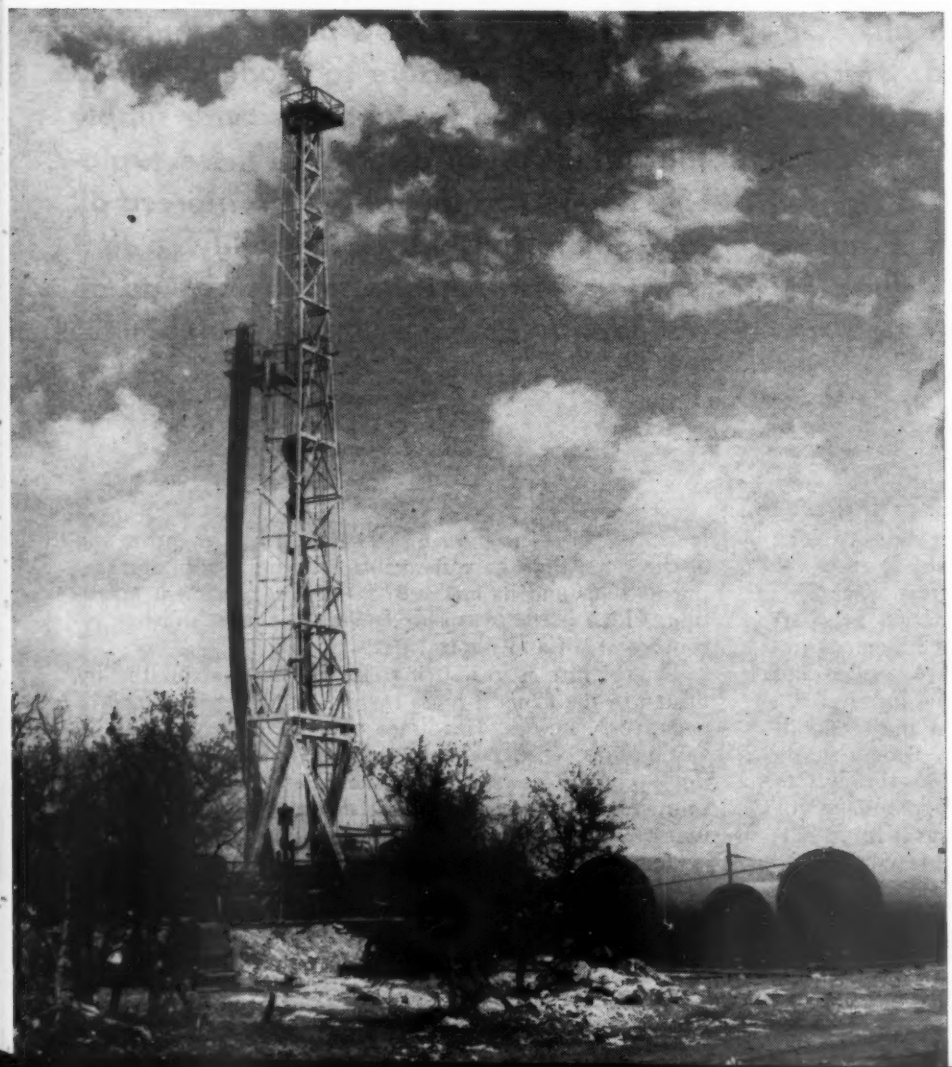
Sim H. Crews
Editor, Drilling and Producing

Near Burksville, Kentucky it was customary to bottle and sell the oil for medicinal purposes for 40 or 50 cents per bottle. Widely advertised as a specific cure for burns, bruises, sprains, coughs, rheumatism, and other ails and as a valuable aid in the erradication of flies, it was called Seneca Oil. In 1845, crude oil mixed with sperm oil began to find a market as an economical machine lubricant. By 1850, demand for medicinal purposes, lubricants, paraffin, and lamp oil had raised prices to $40 a barrel, materially increasing the supplemental revenue from the brine wells and leading to the first premeditated oil well drilling venture near Titusville, Pennsylvania. By the end of 1860, a total of 84 producing wells had been drilled — and the price of the oil reduced to 5 cents a barrel.

These early efforts were indeed a far cry from our ever-deeper modern penetrations. It was about 1820 when wells were first drilled to 1000 ft. By 1927 we had passed the 8000-ft mark. Only 20 years ago in 1933 we had drilled to within 50 ft of the 11,000-ft level, and by 1938 we had passed 15,000 ft. The Superior Oil Company in Sublette County, Wyoming established a record of 20,521 feet in 1949 that held until August of this year when the Ohio Oil Company in its deep Paloma field exploration in Kern County, California exceeded it.

This progress is the product of men and material — the application of science in design, science in operations, and science in investment. The components responsible for drilling progress are but best judged when separately considered.

JACK-KNIFE MAST at work in West Texas.



Derricks

Possibly the most striking advance to the casual observer is in derrick science, progressing from the wooden structure of Captain Lucas' day and later, when a 90-ft timber structure was judged adequate for any reasonable purpose, to the towering steel structure 192 ft in height used to deepen the Superior well beyond 20,000 ft. We see tremendous strides in design of structures to support the heavy loads imposed by the deeper penetrations and also in the more ordinary structures designed for normal penetrations and quick, economical rig moving.

Gone are the days when operators were privileged to expend the time and the money required in the erection and dismantling of standard derricks for ordinary drilling. The press of modern economic competition demanded the development of the highly portable, easily and quickly erectable mast, so common in today's operation. Available in heights from 87 ft for shallow operation, to 142 ft, and with load capacity ratings, from 300,000 to 860,000 lb, these triumphs of design have substantially revolutionized the moving phase of the drilling industry. One manufacturer has designed and constructed a 140-ft mast, which is rated at 1,000,000 lb, a machine that will undoubtedly advance the possibility of making today's record depths commonplace events in the future.

Pumps

Unseen at the surface is the true measure of the value of the present high horsepower mud pump. Deeper drilling and economic necessity for faster drilling are the two items most responsible for the increase in hydraulic horsepower requirements on today's rigs. On the earlier steam rigs a satisfactory increase in hydraulic horsepower could be effected by compounding available pumps. This has proved impractical with power pumps, and as a consequence manufacturers now offer these power pumps with 700 hydraulic horsepower ratings. Frequently these pumps are equipped with engines and compounds capable of imparting up to 1400 engine horsepower.

The required pump capacity for a rig depends upon circulated volumes and circulating pressures. Volumes should be sufficient to induce annular return velocities adequate to efficiently remove all cuttings from the hole. Some operators desire that this velocity ap-

proach 175 ft a minute. Circulating pressure is the result of friction loss inside the drill pump and in the annulus, friction loss in surface connections, and pressure drop across the bit nozzles. Calculations show that 305 hp are required to circulate 500 gpm through 12,000 ft of 4½-in. drill pipe. As the circulation rate is increased to 600 gpm, the hydraulic requirements for overcoming friction increase to 530 hydraulic horsepower.

Other friction losses are important, but small when compared to the loss in the drill pipe. The ability of the jet stream at the bottom of the hole to accomplish useful work depends, of course, on the energy it contains and the penetration rate will be a direct function of this energy content. Considering the horsepower lost through friction, it is obvious that there must be an improvement in the hydraulic horsepower capacity of rig pumps if the penetration rate is improved in accordance with the economic necessity. This, then, explains and justifies the present modern trend to the high hydraulic horsepower units.

Hoisting Equipment

Drawworks design, too, has advanced far beyond the days of the first unitized hoist. Though not ordinary and definitely built for today's record wells, they are available with input horsepower rating in excess of 2000 horsepower. One of these modern giants has a drum shaft 36-in. in diameter with 2 brake flanges over 5 ft in diameter and almost a foot wide. This particular drawworks can exert a pull of almost 100,000 lb on the fast line and has a drum peripheral velocity in high of 3860 fpm, almost 45 miles per hour.

Used in conjunction with modern power transmission compounds, and equipped with air clutches and a hydromatic brake, this unit can handle drill pipe loads of 200 tons with a facility undreamed of a few years past and foretells well the greater depths to be gained in the future.

Drill Collars and Stabilizers

It is considered that a bit loading of 5000 lb per inch of bit diameter represents a good maximum practice and this limit is generally observed with the possible exception of larger sized bits because of apparent premature bearing failures under higher loads with little perceptible increase in penetration rates. The use of excessive bit loads creates several problems. A definite program for the use and care of the long drill collar string is required, there is a problem in fishing for drill collars and bit cones and there is an increased tendency toward hole deviation.

Drill collar failures have been materially reduced through the development of properly balanced box and pin sizes and the stress relief of drill collar connections. The establishment of routine inspection procedures, primarily through the use of magnetic particles, has also been extremely effective in the reduction of failures. The development of special fishing tools for cone recoveries and the use of heavy mills to break up lost cones has reduced losses from this source. Also better control of drilling weights and more attention to rotating time coupled with a general reduction in rotary speeds has proved effective. A large portion of the deeper wells drilled penetrate what is called "crooked hole" sections and are forced to proceed in these sections with greatly reduced weight on the bit and with consequent reduction in penetration rate. In an effort to alleviate this problem, many operators now employ some form of stabilization, such as string reamers with smooth rollers placed at various points in the drill collar string.

Other operators are using sleeve stabilizers with a fair degree of success. It has been found that large drill collars, often with an OD within one inch or less of the hole diameter, have been effective. This, of course, presents a fishing problem in that a wash-over job is impossible, but to date, little trouble has been experienced through the use of these oversized drill collars.

★ ★ ★ ★ ★ ★ ★ ★

With costs doubled and revenue per foot drilled practically unchanged since 1941, only bright spot in drilling picture is 42 per cent gain in penetration rate achieved through improved efficiencies.

★ ★ ★ ★ ★ ★ ★ ★

Bits

Excellent progress in the quest for deeper holes has evolved through the advances in bit development seen in recent years. Of most importance are two: the jet bit, both drag and rock; and the chert bit.

The principle of the jet bit is, of course, well known. Through hydraulic action it scours the bottom of the hole ahead of the cutter, removing loose particles and preventing redrilling. It also, in softer formations, carries a considerable cutting action of its own through the pure application of hydraulic energy.

The mis-application of these bits, (that is, their use on rigs with insufficient hydraulic horsepower to overcome the friction loss within the drill string and to have remaining sufficient energy to utilize the general principle upon which the design of the bit is based) has caused their summary rejection in some instances. Properly applied, however, they have proved their efficiency many times with increases in penetration rates approaching 50 per cent and in other cases with increases in footage per bit approaching 50 per cent, even when penetration rates were not materially improved. Primarily the use of jet bits is a problem of balancing pump horsepower, hole size, and drill pipe size.

The advent of the chert bit in West Texas was greeted with considerable skepticism. Based on the principle of drilling through crushing action, the round sintered tungsten carbide teeth with which this bit is equipped, are certainly most unimpressive. Results indicating an increase of 500 to 700 per cent in footage per bit through use of these bits over conventional rock bits has been noted, and in some cases the increase has been as much as 20 times conventional rock bit footage. One operator has estimated that in spite of the high initial cost of these bits, they will be more economical to use in any formation where they deliver 2½ or more times the footage anticipated from a conventional bit.

Air Drilling

Recent expanse in the use of air or natural gas as a circulating medium for rotary penetrations is significant. Although not applicable to all drilling problems, this method offers several advantages over conventional circulatory systems where it can be employed. The substitution of air or gas for the circulating medium has four advantages over rotary drilling. These are: Less possibility of injuring producing zones through drilling fluid loss, and of contaminating cores and samples, reduced susceptibility to loss of circulation, and experienced increase in bit life and penetration rate.

The process is presently limited to those areas where water-bearing strata and sloughing formations are not anticipated. The method also has a disadvantage in that there is a loss of control of well pressures. Properly applied, however, it has great promise for increased penetration rates with subsequent reduction in drilling costs.

Muds

Improvement in the technique of drilling mud design and control is a continuing function. Perhaps the advent of the oil base and the oil emulsion muds are the most significant of the recent developments. One primary objection to the use of these muds, the contamination of samples with oils and subsequent difficulty of geological evaluation, has been eliminated. Oil base and oil emulsion muds are credited with substantial increases in penetration rates and bit life and have become a valuable adjunct to the driller in his quest for economies in penetration.

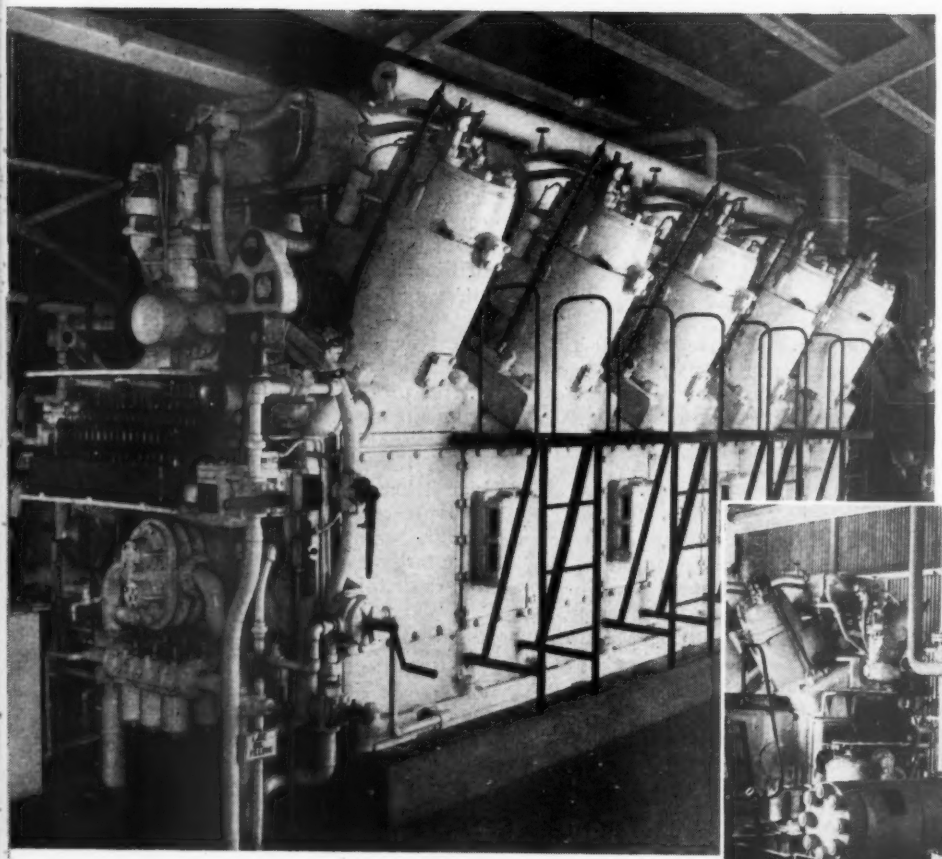
Other developments in more conventional type muds such as those designed for low jellation effects under high temperatures, improved viscosity characteristics, and improved carrying characteristics coupled with ease of maintenance of desired weights, have continued apace and promise well for future drilling ventures. ➡

XUM

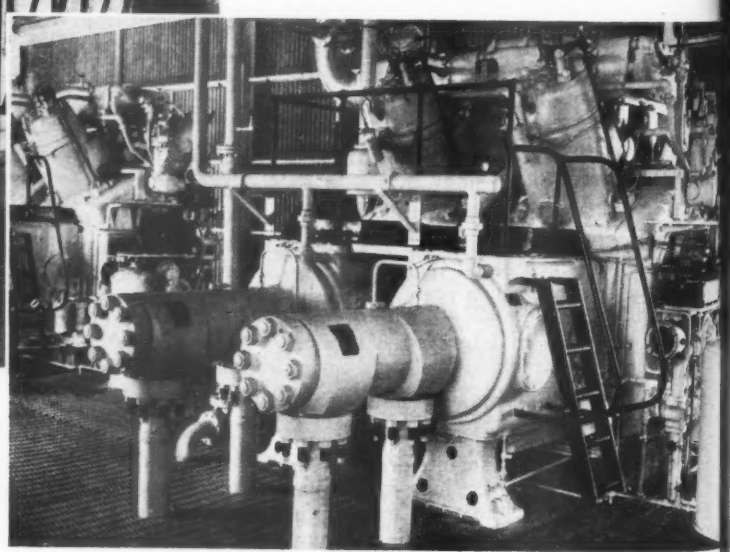
THEY COUNT ON THESE GMV's

for smooth operation in high-pressure ammonia service

Another Example of Efficient Power at Lower Cost



Crankdoor side of one of the GMV-10 process units, showing operating end with automatic control devices.



Close-up of high pressure compressor cylinders on one of the GMV-4 units in recirculator service—first application of its kind.

ANGLE

Compressors

New York Washington, D. C. Bradford, Pa. Parkersburg, W. Va

San Francisco, Cal. Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle, Wash

6300 hp line-up of GMV-10 and GMV-4 V-angle compressors in a large Texas synthetic ammonia plant. GMV-4 recirculator units are in foreground, GMV-10 process units in background.

IN this Texas synthetic ammonia plant, these modern, reliable Cooper-Bessemer GMV's help in a big way to keep the process running smoothly. For example, GMV flexibility permits effective, dependable automatic control — set in this case to maintain constant suction pressure.

The compressor line-up consists of seven GMV's. Two are recirculator units — the *first* 2-cycle gas engine compressors to be used for such service. The other five are GMV-10 process units compressing a hydrogen-nitrogen mixture, through 5 stages, from 2 psig to 5300 psig.

Here, in Texas, this same company operates *fifty-four additional* GMV's in 4 light hydrocarbon plants — plenty of experience to know that GMV quality and features pay off. In fact, Cooper-Bessemer V-angles are doing a real job in many a chemical and petrochemical plant . . . offering installation and operating economies seldom if ever matched.

by Cooper-Bessemer

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

Tulsa Shreveport St. Louis Los Angeles Chicago Caracas, Venezuela

Petrochemicals Steal Spotlight in 1953 . . . . . .

ARCH L. FOSTER

ALTHOUGH the combined production of petrochemicals amounts to a very small fraction of the petroleum industry's total output of salable products, the activities of the petrochemical division has absorbed a good portion of the attention of the industry and the world in general during this last 12 months. According to the best figures now available phenomenally growing chemicals-from-petroleum had, in mid-1953 58 units under construction, totalling an estimated $500 million in plant expenditures, sums that will be spent by or before the end of 1954, here and abroad.

ARCH L. FOSTER
Editor, Refining and Petrochemical Edition.

These petrochemical ventures, in a majority of cases are either joint ownership companies by chemical and petroleum-refining companies, or are developments by organic chemical companies that are built alongside one or more refineries, from which the chemical maker obtains raw materials such as olefins, olefin-diolefin mixtures or simply "waste" hydrocarbon byproducts from refinery processes for which the refinery has no other use than plant fuel, lowest paid outlet for petroleum fractions.

In some cases such as Texas (Tennessee) Eastman Company, at Longview, in the famous, sprawling East Texas crude oil field, casinghead or natural gas is obtained as such, normally stripped gas from gasoline plant processing, which by thermal cracking or catalytic dehydrogenation, or oxidation are made to yield the finished or intermediate products wanted. Still others, like National Petrochemicals Corporation in Illinois take raw gas from a pipe line and remove the condensable hydrocarbons, then take part of the lighter hydrocarbons — ethane to butanes — as raw material for chemicals.

It is estimated that petroleum chemicals constitute 70 per cent of our total (U.S.) organic chemical production, and that the growth rate is 14 per cent annually, higher than in any other industry. Of all products now made in quantity ammonia and its immediate derivatives show the highest tonnage, it is believed. Much of this ammonia is consumed by the chemical industry as intermediate for other finished products. The great portion of it goes into fertilizer ammonia, either as the nitrate — nitric acid made by oxidation of ammonia from the production — or as sulfate, by combining with what is frequently waste sulfuric acid. A large part of this ammonia is shipped abroad to European and other countries to build up their food-producing capacities.

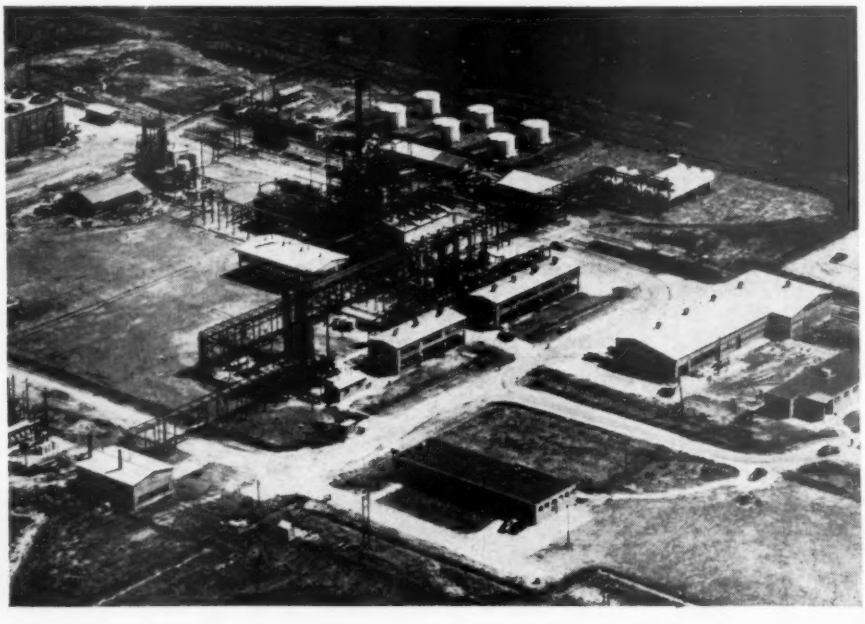
The greatest single organic chemical intermediate, in terms of quantities and the range of its application is ethylene, progenitor of innumerable plastics and other finished products. Last spring Bakelite, Carbide & Carbon affiliate, disclosed its broad, three-plant expansion program on polyethylene, the plants at Seadrift, Texas City, Texas, and Torrance, California. This summed up the expectations as follows: For production of this "wonder plastic" by 1955; Bakelite, 250,000,000 lb; Dow Chemical, 20,000,000 lb; du Pont, 100,000,000 lb; Monsanto, 66,000,000 lb; National Petrochemicals, 50,000,000 lb; Spencer, 45,000,000 lb, and Tennessee Eastman, 20,000,000 lb, for a total of about 551,000,000 lb.

Phenol, a widely used chemical in industry, both as an intermediate and a finished chemical, is now being made

Petrochemical Plants Announced Recently

	Company	Location	Product	Probable amounts to be spent, dollars	Probable completion date
1.	Allied Chemical and Dye—Nitrogen Div.	Hopewell, Va.	Ammonia	4,000,000	
2.	American Cyanamid	New Orleans, La.	Methyl styrene	7,840,000	
3.	American Petrochemical	Lake Charles, La.	Polyethylene	15,000,000	
4.	Brea Chemicals Corp.	Wilmington, Calif.	Ammonia	13,000,000	Late 1953
5.	Carbide and Carbon Chemicals Corp.	Seadrift, Texas	Polyethylene, ethylene oxide	42,000,000	April, 1954
5.	Carbide and Carbon Chemicals Corp.	Torrance, Calif.	Polyethylene	36,000,000	Dec. 1954
6.	Commercial Solvents Corp.	Louisiana	Ammonium nitrate		
7.	Delta Chemicals	Louisiana	"Petrochemicals"	?	
8.	Diamond Alkali	Houston, Texas	"Petrochemicals"	2,000,000	
9.	Delaware Chemicals	.....	Pentaerythritol	1,000,000	
10.	Dow Chemical	Freeport, Texas	Glycerine	5,485,000	
11.	DuPont Co.	Tennessee	Dacron	10–20,000,000	1954
12.	Eastern States Petroleum	Houston	Ethylene	4,000,000	1954
13.	Esso Standard Oil	Baton Rouge, La.	Higher alcohols	?	1954
14.	Grace Chemical Co.	.....	Urea, ammonia	19,000,000	Late 1954
15.	Goodrich Chemicals	Kentucky	Acrylonitrile	8,500,000	1954
16.	Goodrich-Gulf Chemicals	Texas	"Petrochemicals"	80,000,000	Late 1954
17.	Hancock Oil	Long Beach, Calif.	Ethylene glycol	?	Early 1954
18.	Hercules Powder	Gibbstown, N.J.	"Petrochemicals"	8,000,000	Jan. 1954
19.	Heyden and Monsanto Chemical	Texas Coast	Methyl alcohol	8,500,000	1955
20.	Lion Oil	Luling, La.	Ammonia, etc.	31,000,000	Late 1954
21.	Mathieson Hydrocarbon Chemicals	Brandenburg, Ky.	"Petrochemicals"	17,000,000	
22.	Matholin Corp.	Lake Charles, La.	Hydrazine	3,000,000	Early 1954
23.	Monsanto Chemical	.....	Cortisone from toluene	18,500,000	
	Monsanto Chemical	.....	Ammonia	16,800,000	
	Monsanto Chemical	Avon, Calif.	Phenol	?	Early 1954
24.	Oronite Chemical	Richmond, Calif.	i-Phthalic acid	?	
25.	Pa. Industrial Chemical Corp.	Pennsylvania	"Petrochemicals"	?	
26.	Phillips Chemical	Borger, Texas	Carbon Black	2,000,000	
27.	Quimico	California	Tetraethyllead	1,200,000	
28.	Shell Chemical	New Orleans	Glycerine	?	
	Shell Chemical	Houston(?), Texas	Propylene for acetone	6,300,000	1954
29.	Spencer Chemical	Orange, Texas	Polyethylene	15,000,000	1954
	Spencer Chemical	Vicksburg, Miss.	Ammonia	14,000,000	1954(?)
30.	Stauffer Chemical	Kentucky	Methylene chloride	2,118,600	
31.	Stauffer Chemical	.....	Not announced	22,000,000	
32.	Standard Oil of California	Richmond, Calif.	Phenol	4,000,000	Spring, 1954
	Standard Oil of California	Richmond, Calif.	Para-xylene	?	
33.	Standard Oil of Indiana	Whiting, Ind.	Para-xylene	2,600,000	
34.	Texas Eastman	Longview, Texas	Polyethylene	(20,000,000 lb)	
5.	Utah Chemical Co.	.....	Ammonia, nitric acid	18,800,000	
36.	Warren Petroleum	Houston, Texas	"Petrochemicals"	?	

PETROCHEMICAL plant in Texas Gulf Coast area.



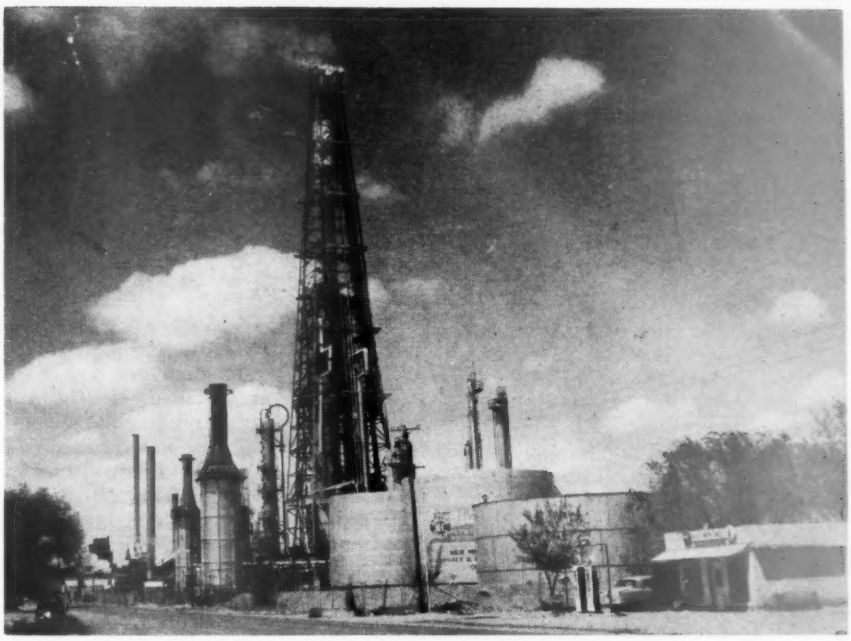
from cumene, itself synthesized from benzene and propylene, with acetone as an important by product. Through the hydroperoxide, cumene is oxidized to break the molecule in two, taking off the side chain as acetone and forming phenol in high yield. At present three phenol-from-cumene plants are building in the U. S. A. and four abroad. One began operation just recently in Canada (B. A. Shawinigan Ltd., Montreal). The U. S. plants are Allied at Frankford, Pennsylvania, Hercules at Paulsboro, New Jersey and Oronite at Richmond, California. These three plants will make about 80,000,000 lb of phenol and about 50,000,000 lb of acetone annually, or about 14 per cent of the country's synthetic phenol capacity, which is approximately 575,000,000 lb.

One of the unexpectable products is large output of glycerine, until recent years a purely natural material from animal and vegetable fats. Five years ago Shell Chemical started a plant at Houston, Texas that makes 50,000,000 lb per year. Just recently Shell began plans for a second glycerine unit at Norco, Louisiana, that will make 25,000,000 lb annually. This will bring up Shell's portion of total production to about 30 per cent.

Hydrocarbon oxidation chemicals are becoming available in huge quantities, the alcohols, aldehydes, ketones, acids, glycols, etc. Celanese has been making large amounts at Bishop, Texas, started a second plant in the Texas Panhandle. Cathage Hydrocol is scheduled to produce astronomical quantities of oxygenated hydrocarbons, at its Brownsville, Texas synthetic fuels plant. It has been making considerable amounts but now is shut down for redesigning and probably refinancing. This shuts down the concentration plant with which Stanolind is recovering these materials. They are relayed then to U. S. Industrial Chemicals adjoining and that company completes the concentration and segregation of the various products. Cities Service at Tallant, Oklahoma, is the old pioneer in this business, and has been making anti-freezes, solvents, etc. for a quarter century or thereabouts.

Correspondingly a large number of chemicals are being produced or are in the picture and plants are building. Sulfur from oil and gas has been largely responsible for making up the shortage of that all-important commodity. Some idea of the extent of the size of operations is obtained from the fact that in 1952 — figures not yet complete — indications are that ten billion lb of hydrocarbons were recovered from petroleum and natutral gas for chemical processing, not including liquefied petroleum gases nor natural gasoline! The above data give a brief and inadequate picture of the situation and present trends; the items in the accompanying table also show the way matters are pointing although this list is not quite complete.

One-word description of refining activities in 1953 — expansion. In 1952 the rated refining capacity was 7,340,000 bbl per day of crude. For 1953, as of January 1, the rated capacity was 8,090,000 bbl per day of crude, a boost of a strong 10 per cent. Processwise, the improved throughput capacity went largely to catalytic cracking for better motor and aviation fuels, and added lubricating oil refining units. Catalytic cracking showed 2,770,000 bbl per day in early 1953, with near 300,000 bbl of catalytic reforming; for 1952 the total of both, without break-down, was 2,190,000 bbl. Catalytic reforming is really coming into its own, for two main reasons.



PACKAGE-TYPE TCC unit is said to reduce cost to small refiner.

The reforming catalysts now in use yield large amounts of aromatics, which may be combined into motor fuel, may be concentrated for blending in aviation fuels for reciprocating engines, or may be used as chemical intermediates. Large quantities of benzene, toluene, (which is used also in explosives synthesis) and xylenes are used for chemicals. Para-xylene is one of the intermediates for manufacture of Dacron, new synthetic fabric material.

Catalytic cracking and reforming are the "Philosopher's Stone" of the oil and chemical industries; the alchemists of the Middle Ages were looking for cata- their main "workhorse" job of improv- their main "workhorse" job of improving and increasing our total production of motor fuels, refiners are able to make aviation fuel stocks of extremely high octane ratings, and to produce huge quantities of aromatics for aviation fuels and as petrochemical intermediates. One major item in favor of catalysis is the fact that the higher boiling portions of the product have as high or higher octane rating as the more volatile fractions. In either peace or war the aromatics potential of catalytic processes is a vital tool in our industrial economy.

Alkylation capacity is being expanded, but not yet is able to produce total needs for aviation fuel. Every refiner is studying his crudes and his operations to find out about making jet engine fuel, tremendous quantities of which can be made in this country on relatively short notice. One major factor is the standardization of jet fuel specifications, on which strenuous work is being done. The important matter is to so write the specifications as to permit maximum fuel production from existing crudes and in existing plants and at the same time to supply fuels having the needed burning properties for satisfactory operation of these tremendously important power plants.

Several types of catalytic cracking and reforming processes have been developed recently to adapt these routines to the small refiner's situation, both as to building and operating costs and to give the desired quality boost to enable refiners to meet competition. Similarly, lubricating oil manufacture is being improved largely by the use of various chemical additives to strengthen different properties, including oxidation resistance, to maintain solid and such impurities in suspension — detergents — in the oil, to enhance load-carrying capacity, lower pour points and thus improve free flow property in low temperatures. More recently one or more new extraction solvents have been produced, which have not yet been proved beyond the experimental stage but which offer possibilities of competing for the jobs of selective solvent extraction of heavy oils for lubricants, high cetane number diesel fuels, removal of undesirable compounds such as sulfur organics in gas and in light oils.

Pipe Lines Take Oil and Gas When Found . . . .

FRANK H. LOVE

PIPE line systems fall into three principal categories: (1) crude oil (2) natural gas, and (3) products lines. Products pipe lines are for the purpose of transporting petroleum fuels from the point of manufacture to the area of consumption; but in the case of the first two categories it is an evident truth that pipe line construction follows the drill. When oil or gas are discovered in quantity it is of no value unless it can be marketed. Thus the need for pipe lines.

Frank H. Love
Editor in Chief

During the last several years activity has been greater than for any like period in petroleum history, keeping pace with accelerated drilling operations. Take a look at where the major discoveries have been made, then check where pipe lines have been constructed, and it will be found that they coincide.

Lands of the Booms

A few years ago production of oil and gas in Canada was of no considerable importance in the overall petroleum picture. Today that situation is changed completely, and witness the growth of pipe lines as an accompanying necessity. The first major crude oil line to be constructed was by the Interprovincial Pipe Line Company from the province of Alberta to Superior, Wisconsin, from where it was moved by lake tanker to eastern refining centers. Now the American affiliate, Lakehead Pipe Line Company, has underway a 30-in. line from Superior to Sarnia to eliminate the use of tankers because movement by this means is impossible during certain winter months. Now being completed is the Trans Mountain Pipe Line system from Edmonton, Alberta, to the Canadian west coast. Several companies are seeking permission to lay a line from gas-producing areas across the western part of Canada and into the U. S. Northwest. Also, a 44-mile products line, Trans-Northern, has been constructed from Montreal refining areas to Hamilton, Ontario, serving heavy consuming areas along the route.

It is not too difficult to determine the areas of greatest development in the United States by observing where pipe lines have had their origin within the last few years. The Permian Basin of West Texas and New Mexico certainly has been active. Only recently two new lines have been laid from that area, West Texas Gulf Pipe Line and Rancho Pipe Line. Also dedicated this year was Sinclair's large-diameter line from Cushing, Oklahoma, to East Chicago, Indiana, which receives a part of its supply out of the Permian Basin from the Basin Pipe Line System, which, incidentally, was completed in 1949, together with the kindred system, Ozark Pipe Line, to move crude oil to midwestern refining centers. Further, a branch line from the West Texas Gulf system connects with the Mid-Valley Pipeline at Longview, Texas. The latter system was completed in 1950 to transport crude into Ohio. Humble Pipe Line Company in 1950 increased the volume of oil taken from the Permian Basin by laying a larger diameter line to the Gulf Coast area than previously in use.

The growing importance of Wyoming as a producing state has resulted in the construction of the Platte Pipe Line Company system from Worland to Wood River, Illinois, and is now being extended to other Wyoming fields.

Service Pipe Line Company is engaged in laying North Dakota's first pipe line. The system will extend from the Tioga and Beaver Lodge fields in the booming Williston Basin to a refinery now under construction at Mandan by Standard Oil Company of Indiana.

Numbered among the major cross-country gas pipe line systems since 1950 are Transcontinental, Texas Illinois, Trunkline, Texas Gas, Michigan-Wisconsin; and during the few years prior to that Tennessee Gas, Texas Eastern, and El Paso Natural's line from the Permian Basin to the California state line from which point to the heavily populated west coast areas it is taken by Southern California and Southern Counties gas companies.

Methods Improve

This accelerated construction activity presupposes a commensurate progress in methods of laying pipe lines and their subsequent operation, and this has been the case. Doubtless there will be still further refinements in construction equipment and procedures, although as in any industry of a highly developed nature it is difficult to visualize just where the improvement can be made.

Rights-of-way are now mapped by aerial photography prior to procurement by landmen and before any actual design planning the right-of-way can be done. Clearing is by means of bulldozers, portable saws, and dynamite—the latest equipment available for these operations. Electric welding of pipe joints is fast and durable and inspection of the welds is now done efficiently by means of radiograph.

The days of debate over whether pipe lines should be laid bare or coated have

BOOMING ACTIVITY has taken pipe lines into many new areas and resulted in numerous construction and operating developments.

they pick it ON PERFORMANCE

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"Oil Country"

Control

Steadily the preference for Cutler-Hammer Oil Well Pumping Control grows. Its performance *proves* it is the genuine Oil Country Control . . . built to oil men's practical specifications not only to start, stop and protect motors and equipment . . . but built to stop the oil country enemies of performance in their tracks.

Aluminum coated cases bounce back the sun's heat. Chimney-draft type ventilation sucks off heat, sucks in cooler air. (You never see a C-H Control cover door propped open to keep it running.) "Out in the open" contacts stay cooler, and, being vertical, shed dust. Ventilator openings are screened, louvred and baffled to keep out dust and dirt and bugs. Neoprene gasketing shields the timer. Excess clock motor torque keeps it ticking along.

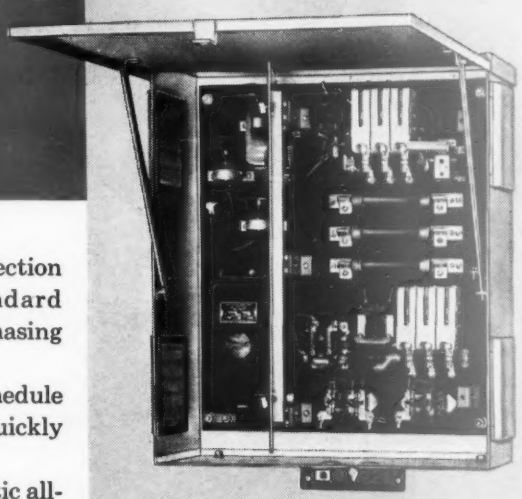
Optional 3-coil overload protection ends single phasing; standard 2 coil suffices where single phasing is not a problem.

Any type of pumping schedule plus day omission is easily, quickly available.

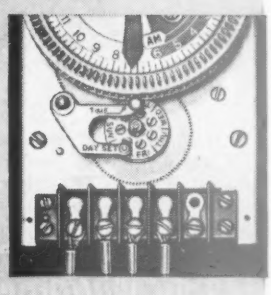
There's manual or automatic all-at-once or time delay staggered starting available.

Lightning arrestors protect but don't blow up the works when they pop.

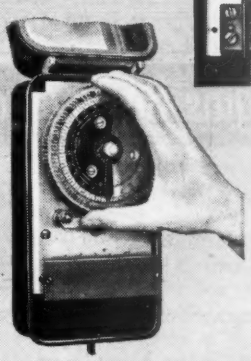
There's every reason in the world for this control's increasing popularity . . . *every reason in the world for you to investigate it too. You'll be glad you did.* CUTLER-HAMMER, Inc., 1459 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.



Cutler-Hammer 9589 Oil Well Pumping Controller with 3 coil overload protection and time delay relay.



Day-omission feature—for non-operation any selected days of week.



Cutler-Hammer Program Time Switch gives automatically scheduled pumping, set up easily by means of pull tabs—one for each 15-minute interval.

Eunice, New Mexico

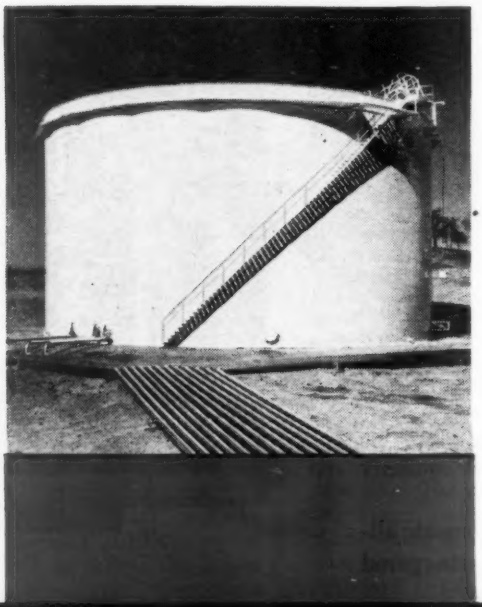
Carter County, Okla.

Scurry County, Texas

MEMBER AMERICAN PETROLEUM INSTITUTE

the important factors in **floating roof design**

number 3 of a series



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The complete, clean drainage of Wiggins Floating Roofs assures year-round protection against paint peeling, rusting, and dangerous accumulation of water.

Wiggins Floating Roofs drain quickly—drain clean—because, they have the steepest pitch of all floating roofs. The patented Wiggins drains are designed to handle loads up to 6″ per hour rainfall. Radial plates with radial welds prevent puddles from forming.

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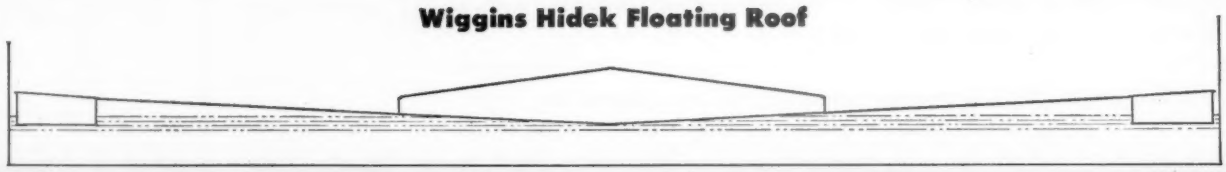
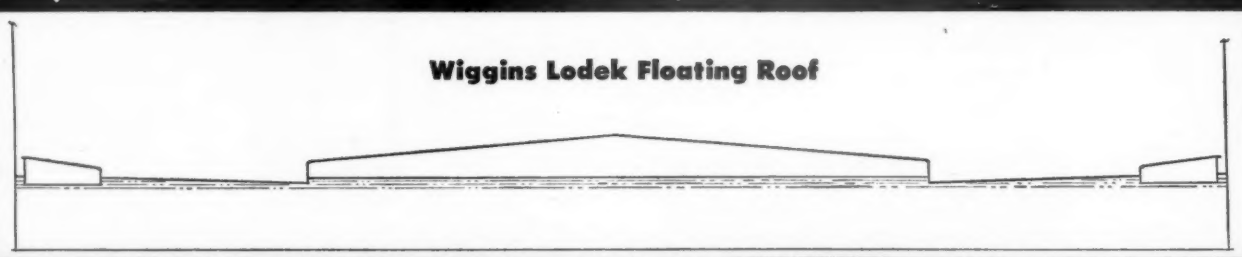


Only Wiggins floating roofs meet every important design specification

Wiggins Lodek Floating Roof



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passed. It is now an accepted practice that pipe lines should be coated and in most instances further protection is provided cathodically either at the time the line is constructed or soon thereafter. Asbestos felt wrapper for pipe has been augmented by the additional use of glass fiber wrap. It is no longer necessary to wrinkle bend pipe; even the largest diameter pipe can be bent smoothly with the machines now used. In fact, the entire matter of laying a pipe line has become a "smooth" and a fast operation.

Automatic Stations

Developments in the actual operation of a pipe line system have been extensive. The systems of today are much more complex than were those of earlier days, yet their very complexity makes them easier to operate, which may seem a paradox. What is meant, however, is that with the many automatic controls that are now an integral part of pumping station, less manual attention is required. Thus stations may be either semi-automatic or they may be fully automatic. A station may be attended by a minimum of operating personnel, it may be unattended and remotely controlled, or it may be fully automatic and controlled by the pipe line stream itself. These are some of the factors that pipe line systems did not start out with early in the century.

There has been considerable change in prime movers also. Centrifugal pumps are employed almost exclusively, except on the older systems that have not been converted from reciprocating pumps. These are driven by electric motors, full diesel engines, and gas-diesel or dual-fuel engines.

Gas compressor stations have undergone greater experimentation than have crude oil pumping stations insofar as prime movers are concerned. The reciprocating compressor unit has been augmented by the centrifugal compressor, which is still in minority use, however. For the most part the latter are driven by gas turbines, although one pipe line company has installed steam turbines at several of its stations for this purpose and the experiment apparently has proved successful.

Microwave Communications

Microwave has become widely accepted as a means of communication, for dispatching, and for certain automatic operations. Under the newer setups for remote station control microwave is employed. By its use not only can personnel of all stations on the system be in immediate contact with each other and with headquarters, but mobile equipment installed in company cars provide a means of reaching field men wherever they may be. Wire line communications, too, have come in for development to the extent that it is now possible to operate from 8 to 16 telegraph channels and 4 to 12 voice channels over one pair of wires.

EVEN THE OUTWARD APPEARANCE of pipe line stations have changed drastically; lower, a modern oil pump station; top, gas compressor station.

Noticeable within recent years has been the increased use of teletype service among pipe line companies. For the transmission of messages, whether it be for dispatching purposes or otherwise, teletype has the favorable factor of providing a written record and the receiving operator can be engaged in other useful work while messages are being received.

The pioneer tank strapper would have been amazed at the electronic tank gaging equipment of today whereby the contents of a tank can be determined without leaving the main station building. Even the gager of a few years ago would have welcomed this time-saving device. Today it is quite common and becoming more so daily. It has a safety feature to it also.

Storage

It is pertinent to mention that the tanks themselves with their floating roofs and other features have also shown a revolutionary development. In connection with them, tank mixers are one of the newer developments. Mixers to agitate crude oil in tanks, and thus eliminate accumulation of bottom sediment, are being installed on old as well as new tankage to an increasing degree.

As an adjunct to gas transmission systems, the practice of storing gas in depleted fields as a cushion against peak winter demand has grown to a remarkable degree. Although in use for some time, not until recent years when consumption of natural gas became so widespread has this practice taken on so great importance. In addition to having gas available underground close to point of consumption at time of greatest demand, and at such time when normal pipe line capacity would be inadequate, it also makes possible the operation of a transmission system at increased throughput during the hot months of low demand. Progress in this respect is shown in recent figures in which gas companies proposed to spend $38,000,000 for storage in 1953 and more than $134,000,000 during the next four years.

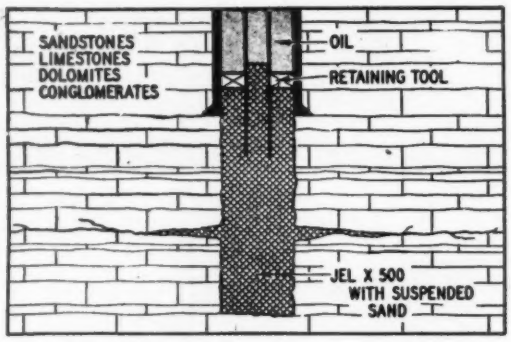
It was mentioned earlier that with the pipe line industry making such rapid progress in the span of a limited number of years, it is difficult to see just what further development can be made. Such a statement is not strictly true, of course, and some of these improvements are already indicated.

Coming Up

It seems probable that in large measure future improvements will be refinements to engineering techniques and ideas now in use and enumerated here. Even greater instrumentation is in the offing. Stations will be subjected more and more to automatic controls. Thin-walled pipe will continue in use where practicable although the need for steel conservation is not so great as it once was. The trend to large-diameter crude oil lines already has been established and is sound practice. This will continue. There should be no slackening in the use of microwave, and telemetering installations could well become universal in pipe line systems.

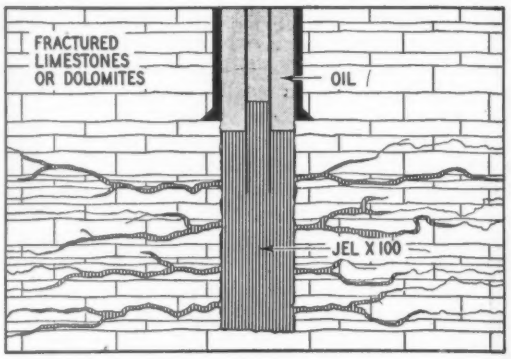
INCREASED OIL AND

Here are the Dowell Services using Jel X materials:



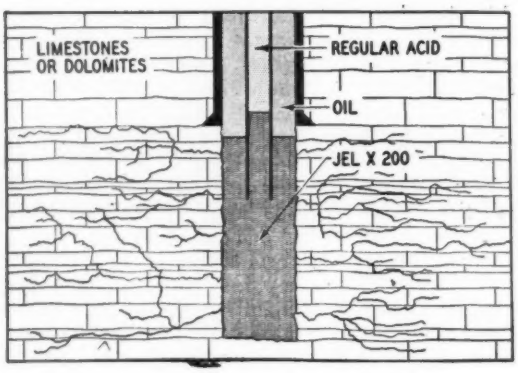
STRATAFRAC

This fracturing service using Jel X 500 has proved effective in limestone, dolomite, sandstone, and conglomerate formations. Stratafrac treatments are designed to dissolve soluble materials including silicates, paraffins and other heavy hydrocarbons and to open new fractures or extend old ones. They carry suspended sand into existing fractures as an abrading and propping agent. No jel-breaker solution is needed following a Stratafrac treatment.



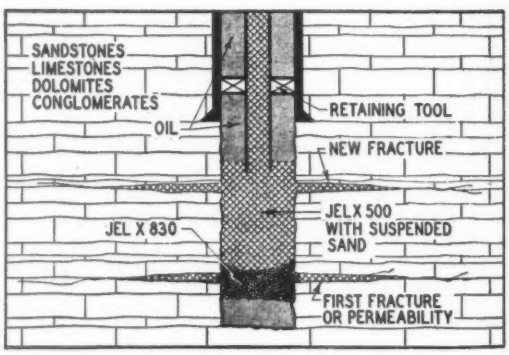
ETCHING ACID

This service utilizes Jel X 100 to permit greater penetration by the acid before it becomes spent. In formations normally requiring large amounts of regular acid, Etching Acid treatments have achieved comparable results with much less acid. They are designed to etch and enlarge "vugs", clean fractures by removing mud, silicate and feldspar materials, permitting better drainage.



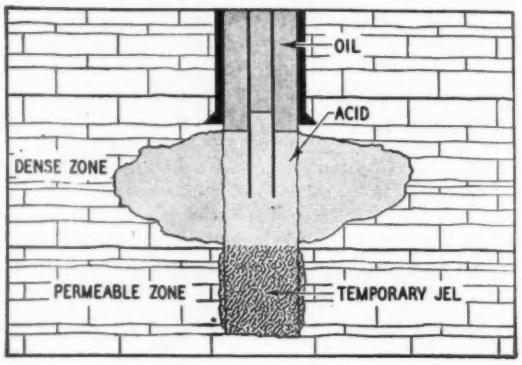
CHANNELING ACID

Channeling Acid Service uses Jel X 200 to form channels deep into pay formations. The acid in this case is mechanically diverted into a relatively few pores. This permits entrance of acid into zones far from the well bore, reaching production which might otherwise remain untapped. Channeling Acid treatments have proved particularly effective in retreating old wells.



FIXAFRAC

Fixafrac is a new temporary plugging service using Jel X 830. It is designed for use between stages of Dowell fracturing treatments to divert treating fluids into different sections. Jel X 830 carries suspended solids which react after treatment causing the material to liquefy and flow back freely to the well bore. No jel-breaker solution is needed following the treatment.



TEMPORARY PLUGGING SERVICES

These services utilize very viscous solutions (Jel X 700, 800, 820 and 900) which have proved effective in selective acidizing. They are designed to shut off the more permeable zones, permitting acid to be injected into tighter formations. Where increased plugging action is desired, the Jel X solutions can be prepared with suspended filler material. Temporary Plugging Services are particularly useful in wells having multiple zone completions.

XUM

Petroleum Supplies Are Always Limited . . . . . .

ERNESTINE ADAMS

OUR editors have shown the progress of the petroleum industry — its tremendous expansion, its positive approach to research, its spirited interest in improveing techniques.

Ernestine Adams
Managing Editor

Now comes the side of the industry with the most questions and the fewest positive answers — its economics.

Economics is an inexact science with wide interpretations. Planners in both government and business have shown up rather poorly in backward glimpses. As in politics and philosophy, the "X" in an economics problem is people and people will persist in throwing an eccentric curve even to the economist who is trying to draw only a simple graph.

Nevertheless we are taking a guess on economic things to come, bolstering our morale with a review of the mistakes of those who made predictions in the past. There was the forecast of a drastic cut in oil consumption after World War II that never came. Then there was the advice of one of the industry's brilliant men when supplies were low in 1948. He suggested the government buy up oil fields in the United States and import oil to pay the owners. Now supplies are high and the "X" of the nation voted it wasn't happy with the idea of the government controlling business and industry.

Right now there is nothing economically wrong with the oil industry that a little less supply or a little more demand wouldn't cure. The traditional treatment for this situation is to push up extra consumption, which is being done, and to hold on until demand hits near the supply level.

In the past one trouble has been that demand turned up suddenly and apparently without warning to wipe out supply margins. There have been several experiences of this type since the war. Gasoline shortages came at one time, fuel oil shortages at another, and there was a scramble to avoid shortages in many products during the refinery strike.

The industry is said to have a 1,000,000 bbl a day production margin and some refinery capacity margin held as response to the appeal of the Petroleum Administration for Defense. This is supported by the industry without subsidy by the federal government. A recent statement by PAD Deputy Administrator LaFortune indicates he thinks the margin sufficient in production and close to it in refining capacity except for aviation gasoline.

What has not been clearly faced by the industry is what margin — of production, refining capacity, en route stocks that fill pipe lines, storage capacity, and personnel — is required to meet the steadily increasing consumer demand. To insure flexibility in widening horizons this margin should be higher percentagewise than ever before. In the matter of refinery capacity margin, PAD shows that this year will average 10.4 per cent compared with 10.9 per cent in 1952; 9.2 in 1951; 16 in 1950, and 18.9 in 1949.

There is one thing that must always be considered in determining operations and policies of the petroleum industry and that is, for the long view supplies are limited, not only in the United States but in the world. Other sources of energy will be available to support the industry — oil shale and coal synthesis, to mention two — but over-supply of liquid petroleum is tied to a limited period and/or a limited space.

As for the overall economy of the United States, it is in a healthy condition although economists predict it is approaching a spell of doldrums. This forecast has been repeated for several years with the dates postponed every month or so. It is always coming in the next six months but a number of these six-month periods have come and gone. There have been changes but no general recession. It is possible the whole economy will not be drastically affected but that single industries or groups of businesses will be forced to make adjustments. In fact, that seems to be what has been going on for some time.

The disturbing factor of lower farm prices cannot be laid entirely to economic ills. Farm prices have been politically manipulated until economic forces are distorted by controls and subsidies. Under inflated prices and the 90 per cent parity payments for leading agricultural products, there has been an influx of the inexperienced into the field and not enough economic sifting to shake out the incompetents.

The economists who have been predicting recession for the last two or three years and are still at it, are getting pretty tired of explaining these phenomena, which indicate a robust economy:

1. August employment reached a record 63,408,000 and unemployment declined to a postwar low of 1,240,000, a minimum level.

2. U. S. national gross income for 1953 is estimated at the record high of $350 billions. (It was $104 billions in prosperous 1929.) People's income for 1953 is estimated at $288 billions, an all time high.

3. Population is adding a record 2,800,000 persons in 1953, bringing the U. S. a total population of 160,000,000.

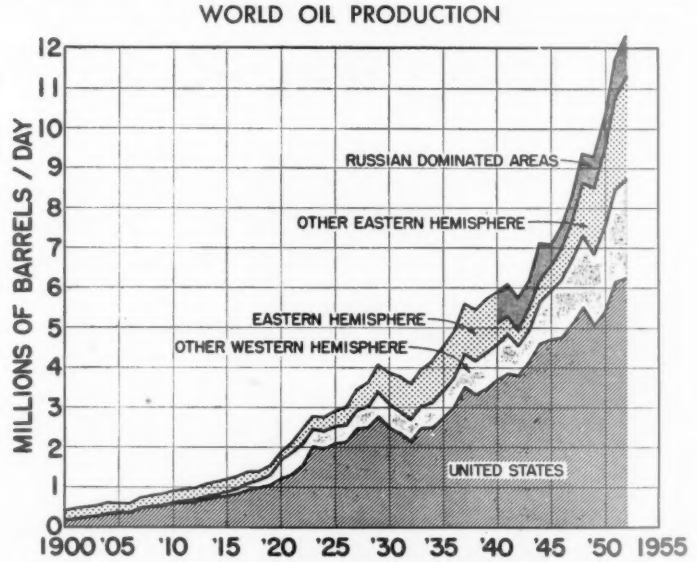
4. Congress has ended price and allocations controls over industry, permitting greater efficiency in production.

5. Revised federal budget has trimmed spending estimates $6½ billions bringing the deficit from a forecast of $9.9 (Truman budget) to $3.8 billions.

6. For first time in years new obligational authority is smaller than the Treasury expects to collect. Figures are:

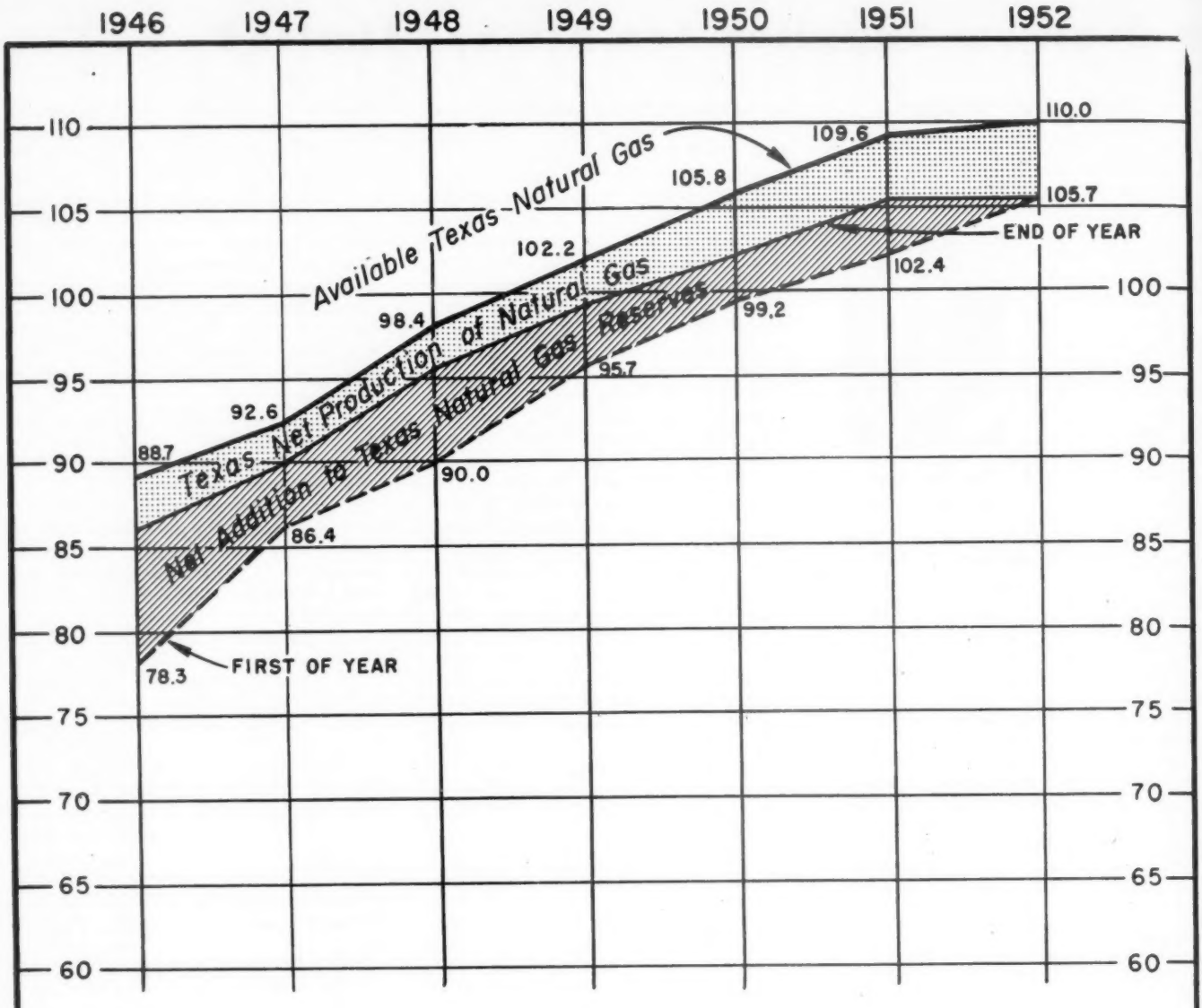
$92.9 billions in fiscal 1952
$80 billions in fiscal 1953
$63.2 billions in fiscal 1954

7. Administration has pledged the



(Chart from "Meeting Future Petroleum Demands," by John E. Swearingen and John W. Boatwright.)

RAPIDLY RISING DEMAND has pushed world crude oil production to higher and higher figures. The big question is not the problem of present overbalanced supply but the problem of meeting future demand. The oil industry must prepare for consumption 5 years or 10 years from now.

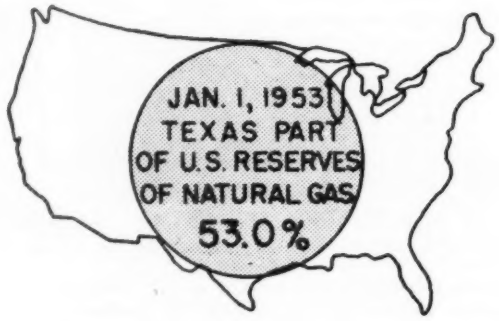


TEXAS

NATURAL GAS RESERVES

(IN TRILLIONS OF CUBIC FEET)

SOURCE: U. S. BUREAU OF MINES
AND AMERICAN GAS ASSOCIATION



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Sohio's Lima Refinery got power dependability without paying extra for stand-by capacity. Westinghouse engineers helped develop a power system which provides a fast restoration of service after interruptions. Westinghouse supplied a control system that automatically and rapidly clears trouble. This system successfully handled twelve power interruptions during the first nine months of operation, without loss of refinery production.

Mississippi Chemical officials called on Westinghouse to help them get a complete "packaged installation" with the best electrical equipment at no extra cost. One feature was that Westinghouse control centers were installed in nonhazardous locations throughout the plant. This gave Mississippi Chemical the advantages of centralized control without paying for more expensive explosion-proof equipment.

Texaco's Eagle Point Refinery got top-system dependability, efficiency and flexibility for future expansion. Westinghouse turbine-generators supply all the power, but there's also a tie-in with the local utility for emergency purposes. Dual-feeder cables carry power to all Westinghouse outdoor load centers. If one faults, the other can handle the full load. All Eagle Point has to do for any plant expansion is add substation capacity.

American Cyanamid and Westinghouse engineers worked out a power distribution system that prevents outages. If there's trouble on any feeder, power is switched to another. If a substation faults, other substations carry the load through cross connections. This system can be easily and inexpensively expanded as the plant grows.

These solutions are only four examples of how Westinghouse equipment and services can meet your power distribution problems. If you'd like more information on the above, or other installations, call your Westinghouse representative. Or write to: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

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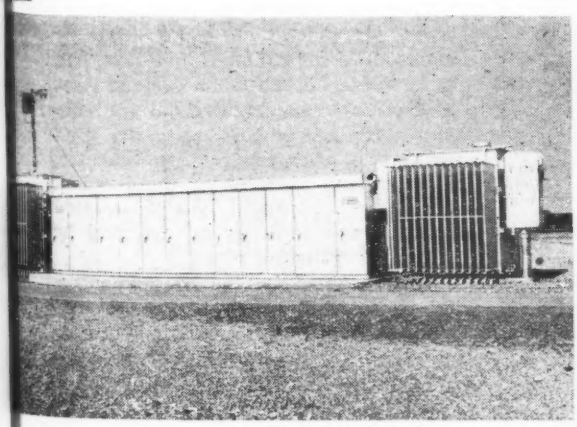
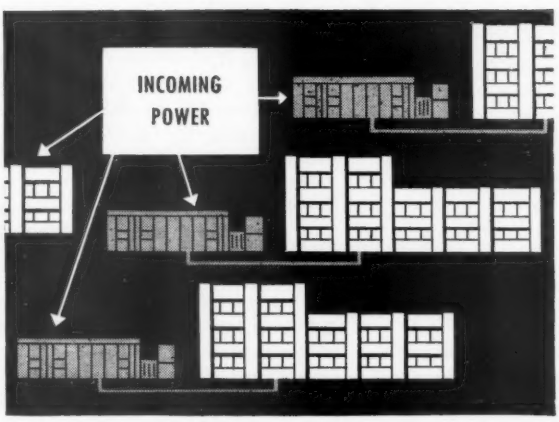
YOU CAN BE **SURE**...IF IT'S

Westinghouse



Eagle Point Refinery's Westinghouse substations are complete with switchgear, transformers and circuit breakers in one, compact arrangement. The system is highly flexible and dependable.



American Cyanamid spotted 10 substations throughout the processing area. When new buildings are added, additional substations will be installed without interfering with production.

XUM

. . . . American Economy Is in Healthy Condition

U. S. government will get out of business so far as possible. (Government-owned synthetic fuel plant at Louisiana, Missouri, has been put up for sale; synthetic rubber plants are to be sold by January 31, 1955; government lands in Alaska are being leased to private companies and Navy exploration is shutdown).

8. U. S. housing is growing at the rate of about a million a year; 1,050,000 housing starts estimated for 1953. (A majority will be fueled by the petroleum industry.)

9. Corporate profits in the first half of 1953 were 15 per cent higher than in 1952, according to Standard and Poore, and the highest since 1950.

10. Federal, state, and local governments are spending $5,453,000,000 in 1953 to build new highways and to repair old ones.

11. Automobiles have reached a record number of more than 54,000,000. (Motor vehicles are all fueled by the petroleum industry.)

12. Tax cuts in individual and corporation incomes begin January 1, 1954 and excess profits tax will be dropped then.

13. There is a better national and even world climate for private capital enterprise. Socialistic experiments have lost some of their appeal for free peoples. From New Zealand to the United States and recently to West Germany the electorate have turned to greater individual responsibility for economic progress.

Failure of the Red Socialist economy revealed by the riots in satellite countries has awakened many to the inefficiency of socialist operations. The decisive West Germany vote for free business enterprise gave that system credit for the increase in productive capacity of 40 per cent above the highest reached in prewar days. Even Tito and Peron have uttered kind words for free enterprise. The world seems to be turning to individual effort as a means to economic gains. It is the challenge that those who believe in the private capitalist system must meet.

So far as the petroleum industry is concerned, it is better off than it has been for years. By using its available intelligence and practical ability, the present phase of readjustment can be used for development of a more staple future, which already calls for greater and more diversified supplies.

1. Demand is at an all time high. In the U. S. it is 8,118,000 bbl of crude oil a day for 1953, according to the Bureau of Mines. First six months showed a 7 per cent increase over 1952.

2. Rise in crude oil prices gives oil companies a chance to improve earnings.

3. New capital investment is at an all time high with a view to being prepared for future increased demand. Spending to bring facilities in line with future needs is approved only after a systematic preview of consumption. There is faith in the future.

4. The "tidelands" settlement has opened up marginal seas to development and the continental shelf will presumably be available soon.

5. Changes in Federal Power Commission are favorable to oil and gas producers. New members are more informer about petroleum operations.

6. The price rise investigation by the Wolverton Committee found the petroleum industry as a whole united against a few malcontents. Testimony by executives of both small and large companies convinced the majority of the Congressional Committee that the industry was doing an efficient job of supplying consumers at lowest possible cost while considering present and future needs.

7. There is reason to believe that the 27½ per cent depletion allowance, so vital to bolstering U. S. supplies, will not be heavily opposed. Those who understand it, as Congress has since 1926, know its value. (A request for a higher percentage allowance, thought necessary by some, will probably not go far.)

8. Congressman Daniel Reed (R., N. Y.) has proposed that the length of time for depreciation allowance to run should be left to the owner of the capital equipment. This is a hoped-for change, especially valuable to oil and gas companies where depreciation is accelerated by rapid changes.

9. Federal tax on gasoline and diesel oil drops from 2 cents a gallon to 1½ cents on April 1, 1954.

10. Iranian oil will not be on the market in substantial quantities for six months to a year and by that time world demand should be able to absorb it without unbalancing the U. S. import-domestic production problem. This statement is made with the world situation in mind. Aftermath of the Korean War will be either a relaxing of trade barriers or a greater tension that will increase preparation for war. More oil supplies are needed for either course.

★ ★ ★ ★ ★ ★ ★ ★

Overproduction is the most pressing problem of the oil industry and it is up to state regulatory bodies and to oil companies to use their experience and good sense to carry us through this temporary unbalance. The point to keep in mind is that this is a temporary situation; for the long term—***Petroleum is limited.***

★ ★ ★ ★ ★ ★ ★ ★

The most important aspect in the American economy to the petroleum industry (and most others) is that the essential "X" is upgrading itself. Not only are there more U. S. citizens than ever before but they know more, produce more per individual, make larger incomes, own more homes and cars, have more leisure, spend more, demand more.

There are more high school graduates and more college and university graduates than ever before. Enrollment in colleges and universities increased 65 per cent since World War II and still business and industry are begging for more trained employees.

Right now American productivity is the world's highest and it is constantly gaining. Despite high cost of machinery, reduced working hours, higher labor costs — the output grows but even faster grows consumers' needs and ability to pay for them.

This is the exhilarating movement of American economy today. Sure there are repeated bumps and continuous readjustments to be made but this is a healthy situation, found only in a dynamic economy. ★ ★ ★

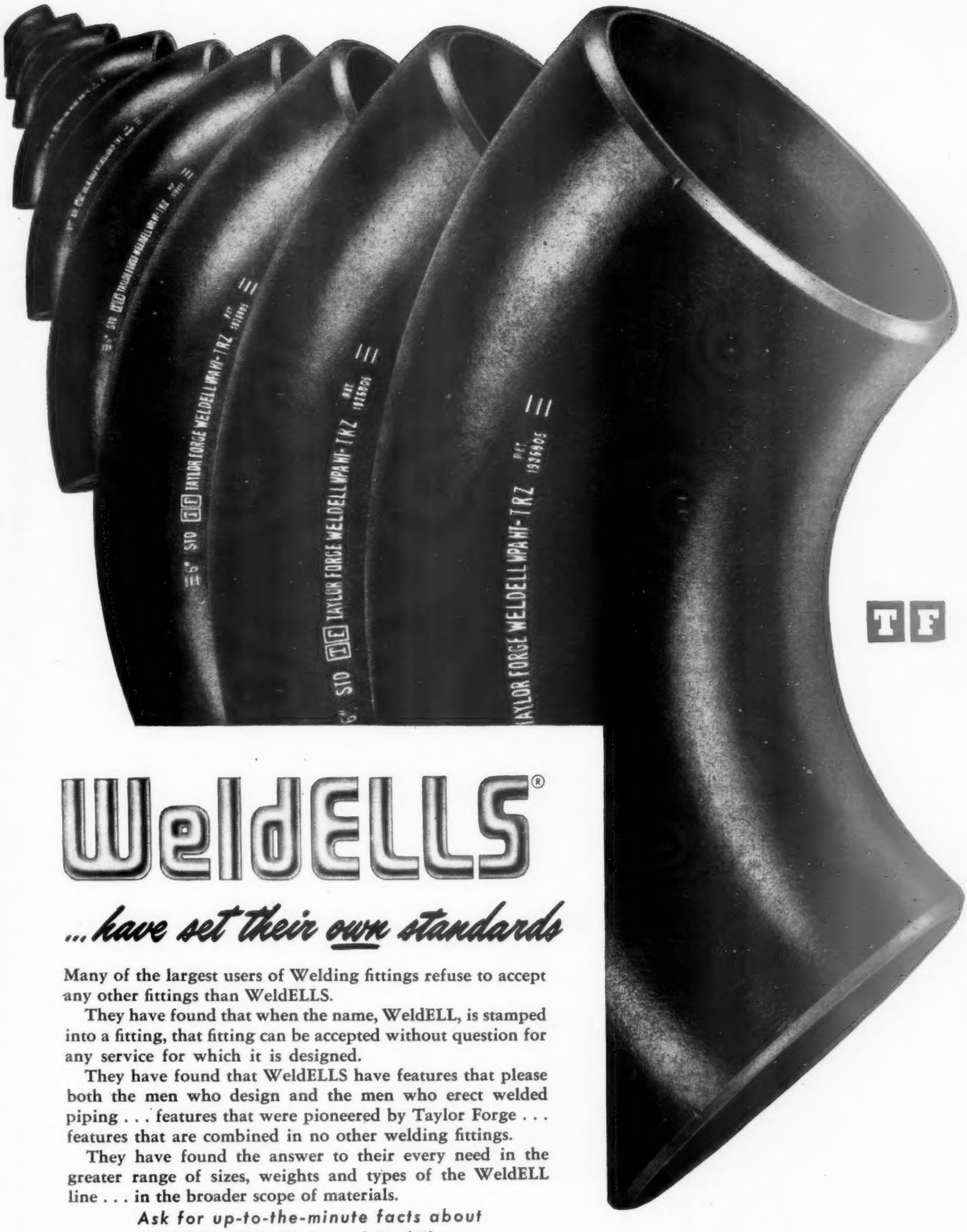
Are You an Economic Hypochondriac?

American businessmen generally are being warned by various industry leaders to hold back their pessimistic prophecies of an imminent depression. Arthur A. Smith, economist for the First National Bank of Dallas, told the board of directors recently that businessmen are conjuring up unhappy portrayal of what the future holds for us and have in effect, "become economic hypochondriacs and could scare themselves sick."

Smith told the directors that basically American economy is sound today. Business is expected to run near its all-time high through the rest of this year, and though 1954 will see some recession, perhaps as much as 10 per cent decline, that does not constitute a major depression.

In another part of the country, Crawford R. Greenewalt, president of DuPont, issue a similar warning. "The surest way I know to start a depression is to predict ourselves into one," Greenewalt declared, calling upon industry to work together to aid the parts of our economy that might be ailing and spend less time in forecasting doom.

The power of mass fright, a general uneasiness and lack of confidence in our economic system could be great enough to bring about the very thing some business men fear. Actually there is little basis for these long-faced prophecies, Smith pointed out in his discussion. At the present time employment is at a new high, and workers in all fields are receiving a higher income than ever before, Smith added.



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POWER OPERATION OF VALVES

Remote control, automatic operation, safety shut-off, and cost savings are the advantages of this system

HYMAN LEDEEN and A. A. TOBEN

POWER operation of valves is becoming more and more necessary to meet these principal requirements: (1) Cut operating costs, (2) permit remote controls, (3) provide safety installations, and (4) permit automatic operations.

One does not ordinarily think of hand operation of valves as a heavy operating expense. It seems that the time and cost of such a simple task as turning a lever or a handwheel would be negligible. In view of present day constantly mounting operating costs, this adds up to considerable expense. In the petroleum industry extensive study is being conducted to permit automatic operation of producing properties. The conventional routine of controlling well production timing, gaging of individual wells, directing the flow to gas separators, settlement tanks, gathering clean oil in tanks, and shipment of oil from storage tanks, is to perform all these operations by hand controls operated by production men or "pumpers and gagers." In most cases these operations are of repetitive nature and can be performed by an automatic system with preset timers and controls that will "direct" the flows in proper sequence and directions provided the flow control valves could respond to signals from the central control panel or instruments, such as automatic level indicators on tanks, etc. Power operated valve actuators that could be adopted to conventional line valves become important components of such automatic production and gaging systems.

It is rather difficult to give correct cost figures for these installations due to the variety of problems involved, the diversity of requirements for different types of production, and the relative novelty of such installations, but it has been established that an average installation for operation of 50 to 100 wells in one vicinity could be amortized in the neighborhood of two years and become very profitable thereafter.

In other industries where automatic or remote control of power valves has become an established practice, more exacting cost figures have been computed and we can quote the following example. In one chemical plant, there is a group of about 60 large size plug valves that have to be operated at frequent intervals. It takes a crew of four men for each shift, or a total of 12 men for 24 hour day. Each of these men costs the plant about $5000 per year, or a total of about $60,000 per year. The same valves equipped with power operated actuators require only one man per shift, and result in a saving of 9 × $5000 or $45,000 per year. The cost of power operated valve actuators for operation of these valves was estimated to be less than $60,000 and would be amortized in 16 months on the basis of the above calculations.

Not all situations are as clear as this, but it does become evident that a study of valve operating cost is definitely in order. Such a study should include the cost of going to and from the valve, and the cost of errors in failing to follow operating instructions accurately.

In other cases, power operation of valves is required for:

Remote Controls. Although the operation of some valves by hand is costly, it is nevertheless possible. There are other jobs, however, where hand operation is practically impossible, and power operation of some type is a necessity.

A valve situated in a hot atmosphere or in an inaccessible spot may perform an indispensable service, yet it may be hard to reach or difficult to operate by hand. The valves that must be operated from a remote location, or from a central location, must be operated by power, as there is no other way to do it.

Safety Installations. A valve or a group of valves that must be shifted instantly in the event of an emergency must be operated by power, as the man can hardly get to each valve to operate it within the instant of time that is available, or such an operation may be necessary at times or places when no men are available to do the work. The valve that must shut itself off in the case of power failure, or rupture of main line, must also be operated by power, and instantly.

Automatic Operations. Valves that have to operate automatically in a processing cycle must be operated by power and not by hand. The valve that has to be moved or positioned by instrumentation must likewise be operated by power.

Types of Power for Actuation

To provide the necessary power to actuate the valves, manufacturers have developed several types of equipment, each suitable in a particular field. Basically, these consist of two types—the rotating motor, and the cylinder motor.

Rotating Motors. Electric motors are among the most commonly used. Such motors run at speeds much higher than the valve can move and are, therefore, of necessity, combined with gear trains to reduce the speed.

In recent years, gas turbines and air-motors have also been developed. These two must also be combined with gears to reduce the speed.

Cylinder Motors. The total movement of a valve stem is relatively short. A plug valve will rotate 90 deg, or one-fourth of a revolution rather than many revolutions. A gate valve will move a distance about equal to the diameter.

Rotating motors, such as the electric motor or air motors, are designed basically for high rpm and more constant rotation. While they will rotate or slide the valve and stop when required, they are not working at their best advantage.

For such service, the cylinder motor is often found more suitable.

The cylinder motor is nothing more than a piston in a cylinder directly con-

EXCLUSIVE

The Authors

Hyman Ledeen has been president of Ledeen Manufacturing Company since 1940. A graduate of the University of Colorado, Ledeen was mechanical engineer for Ingersoll-Rand Company from 1920 to 1925, when he joined The Falk Corporation as chief draftsman. In 1934 he became western manager of Falk Corporation in charge of engineering sales in eleven western states. He became president of Engineering Products Company, in 1935 and organized the Ledeen Manufacturing Company in 1940. His company is engaged in the manufacture of air and hydraulic equipment.

Alexander A. Toben was graduated from the University of Grenoble, France, in 1928. For the first four years after graduation, he worked in the automobile industry in France, beginning as plant mechanic and test pilot to acquire practical training, and later as district sales engineer. For the next 5 and one-half years he worked as assistant to Eugene Freyssinet, Paris, world's foremost inventor of concrete processes and products and builder of plants utilizing them. He came to the U. S. in 1938 under contract with Bishop Oil Company as engineer. In 1946 he joined Ledeen Manufacturing, and short time later was named manager of air-hydraulic division.

H. Ledeen

A. A. Toben

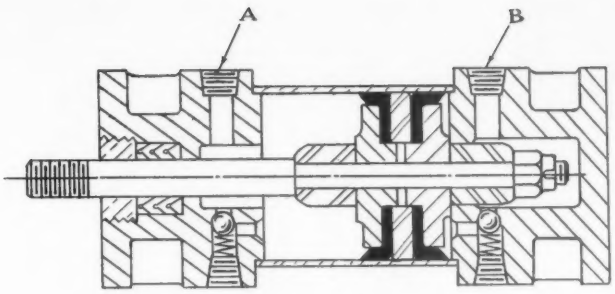

FIG. 1. Cutaway of cylinder motor showing principal parts.

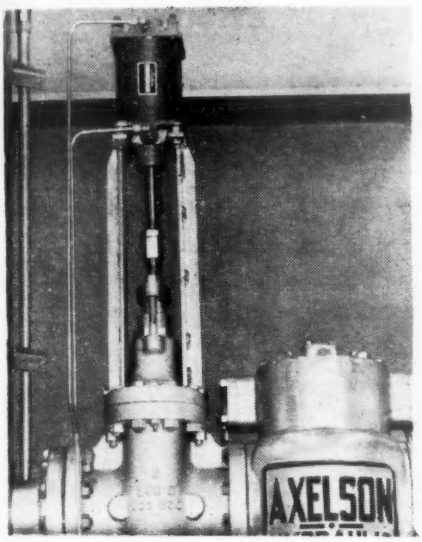

FIG. 2. Cylinder motor installed on gate valve.

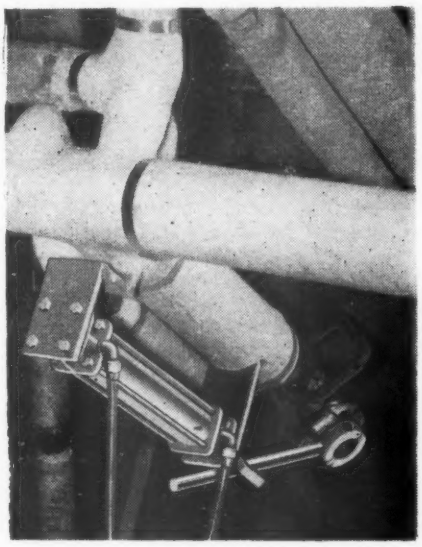

FIG. 3. Cylinder connected to plug valve.

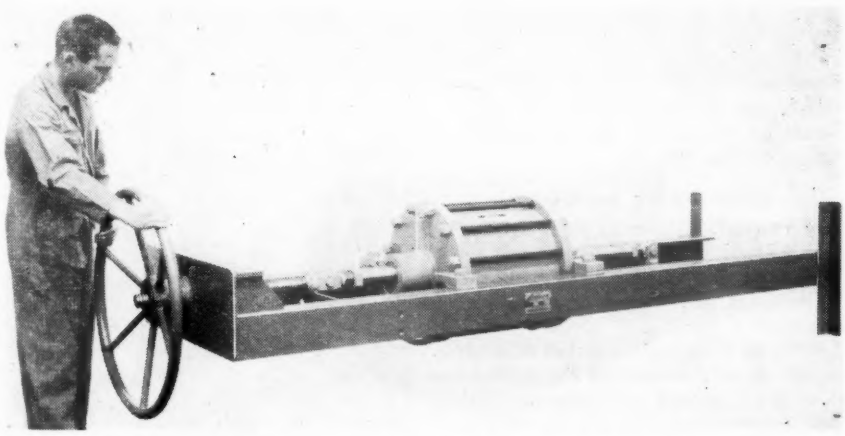

FIG. 4. Cylinder valve shifter operates a slide valve in a catalytic plant.

nected to the valve stem, either by crank in the case of a plug or butterfly valve, or by coupling in the case of a gate or diaphragm valve.

Cutaway of cylinder frequently used on actuators is shown in Fig. 1. Admitting pressure in Port B moves piston toward the left; admitting pressure to Port A moves piston toward the right. Obviously, if the piston rod is connected to some member of the valve, that member will move when the piston moves, and the valve will either open or close.

Cylinder motors are essentially short strokes devices, designed especially for a single movement, and are thus contrasted with the rotating motors that are designed for high speed, continuous movement. Cylinder motors are, therefore, more of a "natural" for valve actuators. Many rotating motors in service are quite satisfactory, but the cylinder motor which eliminates the gears and speed reduction and is connected directly to the valve, in many cases seems to fit in better with the motion of the valve itself.

Applications

Fig. 2 shows a cylinder motor installed on a gate valve which is part of a hydraulic oil well pumping unit. Note the direct coupling connection of piston rod to valve.

Fig. 3 shows a cylinder connected to a plug valve in a gas plant. Note that the piston rod actuates a crank that turns the plug.

Fig. 4 shows a cylinder valve shifter to operate a slide valve in a catalytic plant. Note the use of a handwheel for operation in the event of pressure failure.

Fig. 5 shows a cylinder actuator for a sluice valve in a copper mine, used for safety shut-off operation.

Under normal conditions, piston is up and sluice valve is open. When electric power fails, a spring reverses the control valve, and water from an elevated tank pushes the piston down, closing the sluice valve.

An arrangement of two cylinders operating a slide valve in a steel mill is shown in Fig. 6. This is a high pressure valve (5000 psi) which requires three positions—forward, neutral, and reverse.

Fig. 7 shows a group of four butterfly valves in a plant for manufacturing phonograph records. These are not large cylinders or valves, but the construction is the same—pendulum mounted, operating crank levers on the stem of butterfly valves.

A stock valve in a paper mill is de-

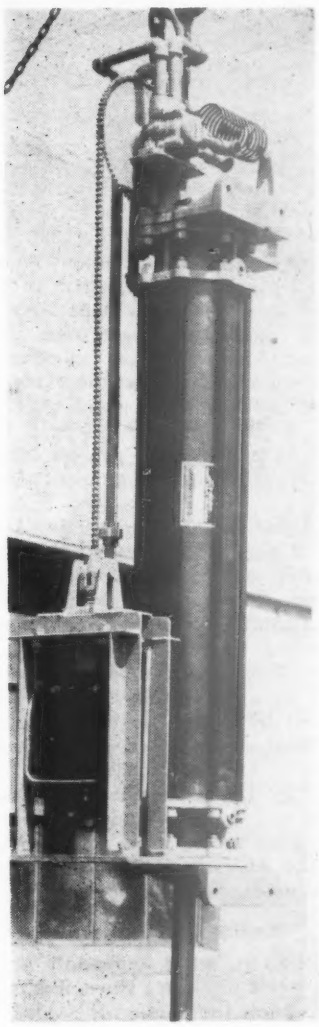

FIG. 5. Cylinder actuator for a sluice valve in copper mine.

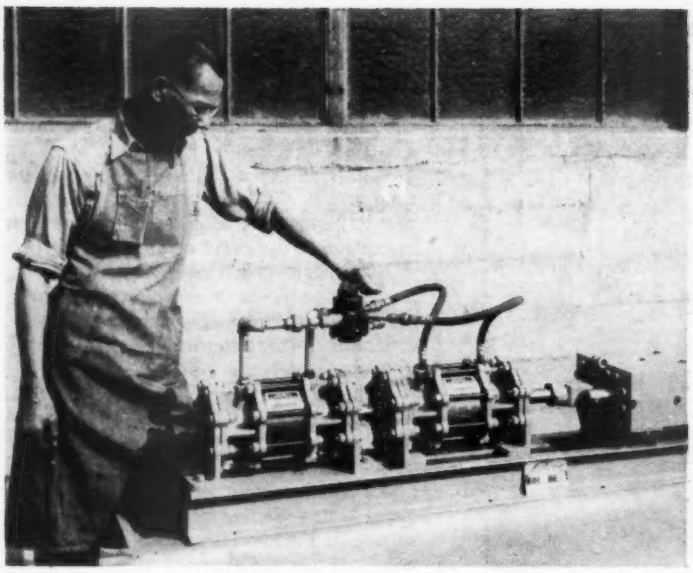

FIG. 6. Arrangement of two cylinders operating a slide valve.

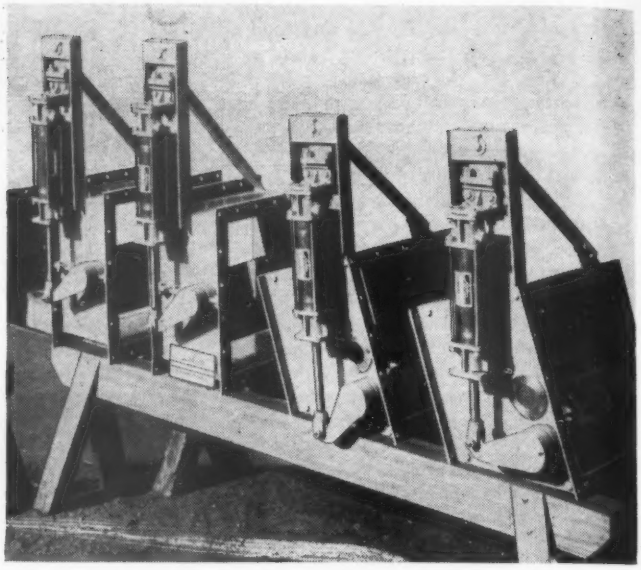

FIG. 7. Group of four butterfly valves used in a record manufacturing plant.

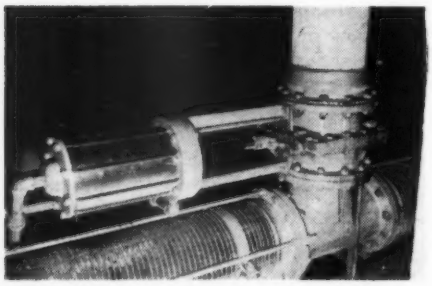

FIG. 8. Stock valve used in a paper mill.

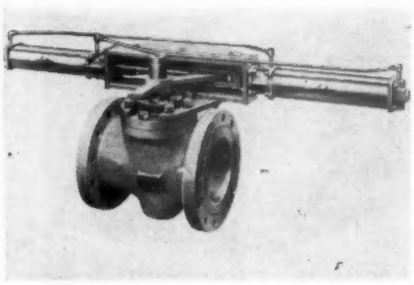

FIG. 9. Two tandem mounted cylinders.

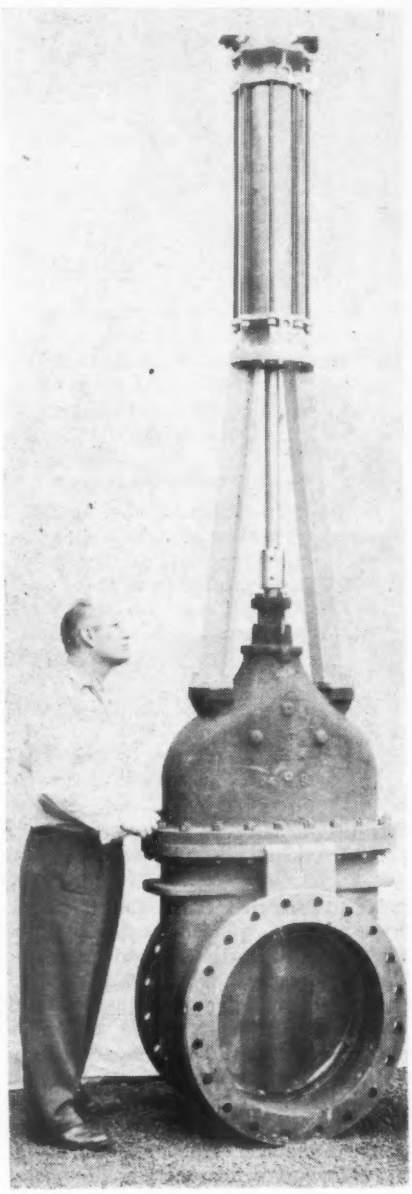

FIG. 10. A 24-in. gate valve actuated by a hydraulic cylinder.

picted in Fig. 8. Here the piston rod is screwed right into the disc of the valve.

In Fig. 9 two tandem mounted cylinders operating a plug valve are seen. Here the cylinders are used to push against the valve lever. Short lever projecting from hub on valve stem in the foreground is a position indicator and can also be used to turn the valve with a snipe in the event of pressure failure.

Fig. 10 shows a 24-in. gate valve actuated by a hydraulic cylinder, similar to Fig. 1. This is used in a large chemical plant.

A single cylinder is mounted on a plug valve in Fig. 11. Piston rod is directly connected to crank on valve stem. Cylinder and control valve are mounted on special bracket supported on the valve bonnet.

Fig. 12 shows a diaphragm valve operated by cylinder. Special bracket is replaced by simple tie rods. Stroke is very short, consistent with diaphragm action.

In Fig. 13 a tandem type actuator similar to Fig. 9, is mounted on small 3-way plug valve, used for automatic operation of gathering and gaging system in production of crude oil.

Load Calculations

In order to select and apply proper size actuator to a given valve, it is necessary to know the load on the valve and the capacity of the actuator.

It is obvious that the load on valve will vary with the type and size of the valve, the line pressure, the type of fluid, and the valve construction. Likewise, the capacity of an actuator will vary with the diameter of the cylinder, the fluid pressure on the piston, and the method of applying the cylinder.

Gate Valve Loads

In a gate valve, the total pull required on the stem will consist of the pull required to break the disc loose plus the pull required to overcome frictions in the valve.

The break-loose pull is rather difficult to figure. It will depend on the smoothness of the disc face and trim, the type of disc construction, the amount of corrosion that has set in, and the jamming effect at the time of closing.

The pull (or push) to overcome friction is also difficult to determine correctly and figures used are close approximations. Several efforts have been made to establish this load formula. Some take a flat 1000 lb as the breakaway load for medium and large size valves. Others take 1500 lb or 2000 lb as a more suitable value. We have sometimes used a value of three times the operating load.

One authority, after many tests, has arrived at the following formula:

$$\text{Load required} = \left(\frac{AP}{3} + 600d\right)K -$$

(see Fig. 14)

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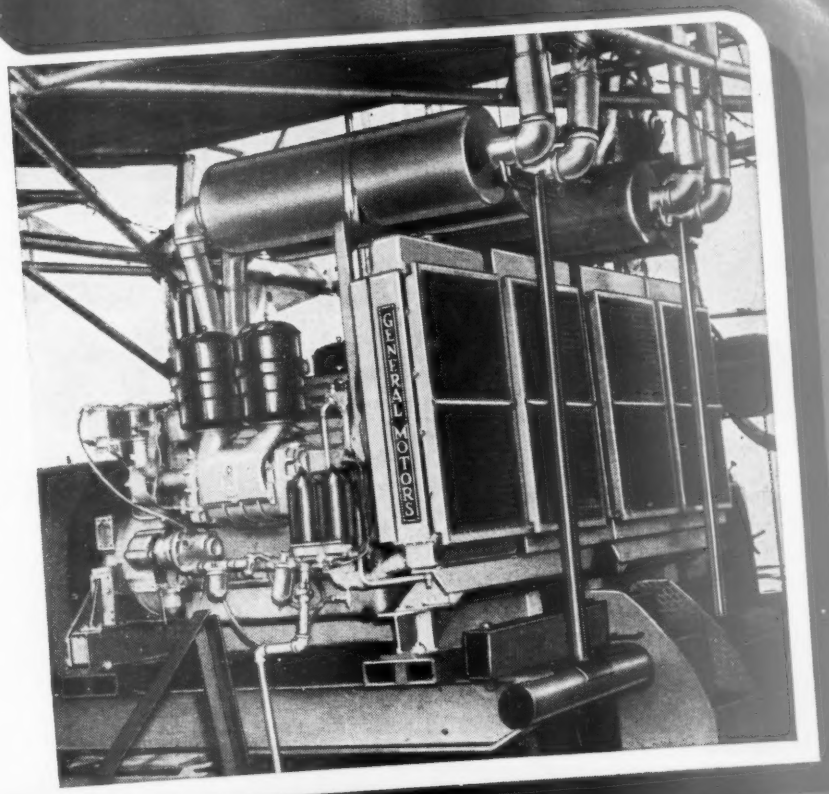

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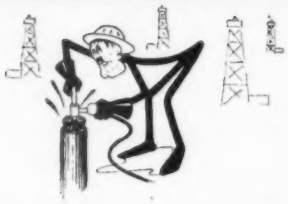

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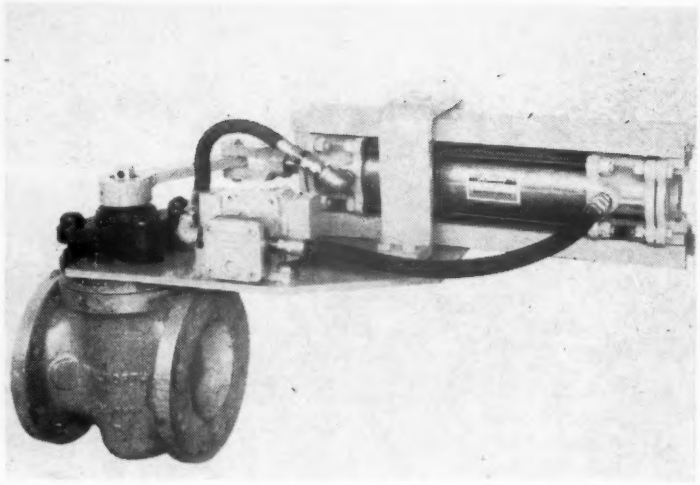

FIG. 11. Single cylinder operating a plug valve.

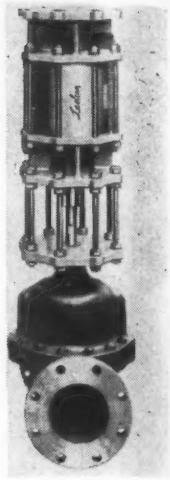

FIG. 12. Diaphragm valve operated by cylinder.

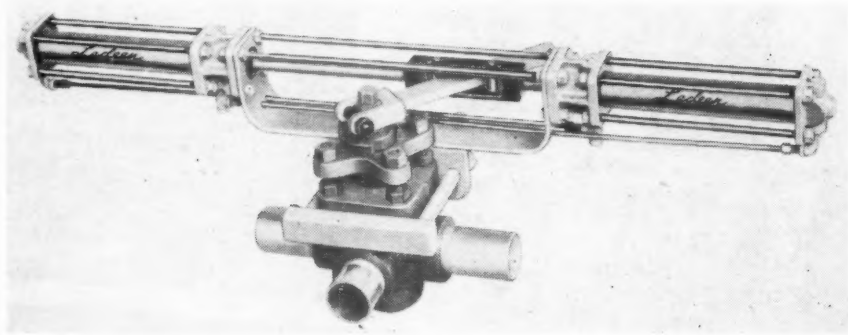

FIG. 13. Tandem type actuator mounted on small 3-way plug valve.

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Where:

D = diameter of valve in inches (valve size)

d = diameter of stem in inches

A = area of valve = $\frac{\pi D^2}{4}$ — in square inches

P = line pressure in lb per square inch

K = an arbitrary factor from 1-3, depending on valve type and condition, type of fluid, and service.

The pull required to keep the valve in motion is more easily calculated, for it will be the product of line pressure, disc area, and the coefficient of friction. In most cases, it is safe to take the coefficient of friction as = .25. This value may be a little high for new valves in excellent condition, but it is a good practical average figure and the equation will be:

$$\text{Operating load} = .25\ PA$$

The total load will depend upon which breakaway load is used, and will be:

$$\text{Stem Pull } SP_1 = 1000 + .25\ PA \quad . \quad (1)$$

$$\text{or } SP_2 = 1500 + .25\ PA \quad . \quad (2)$$

$$\text{or } SP_3 = 2000 + .25\ PA \quad . \quad (3)$$

$$\text{or } SP_4 = .25\ PA + 3 \times .25\ PA = PA \quad . \quad (4)$$

$$\text{or } SP_5 = \left(\frac{AP}{3} + 600d\right)K \quad . \quad (5)$$

By substituting in formula (5)

$$A = \frac{\pi D^2}{4} \text{ we can write:}$$

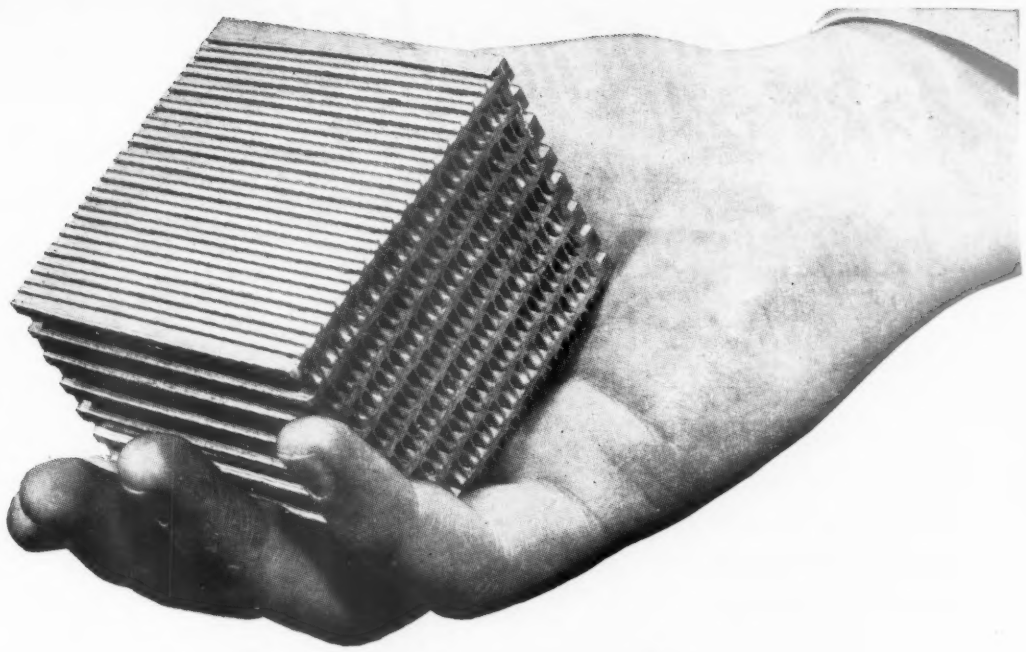
$$SP_6 = (.262D^2P + 600d)K \quad . \quad (6)$$

Formulas (1), (2), and (3) have a rather limited application. Formula (4) is good, but gives values leaning to excess in many cases. Formula (6) gives reasonable practical results. Its only difficulty lies in the judgment required to evaluate the factor K. As an aid to such judgment, the following should be considered:

K = 1 can be used for new, well maintained, double disc valves for AIR or GAS service or other perfect fluid, where accidental malfunctioning is of no great importance.

K = 2 can be used for older, but well maintained valves for heavy but homogeneous fluid; or for valves with wedge type disc, which may have a tendency to stick; or for previously described conditions, but where safety closure or opening is a must.

K = 3 can be used for old, neglected, wedge type valves for sticky fluids (such as asphalt or slurry mixture), where wedging or sticking is critical, and where "safety" closing or open-



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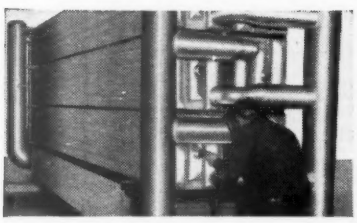

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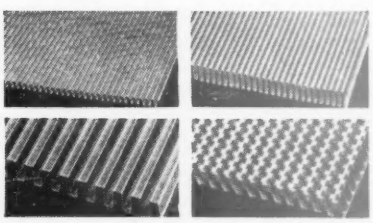

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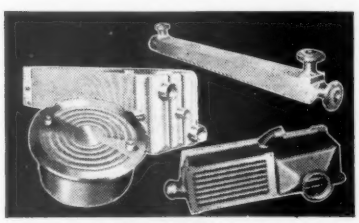

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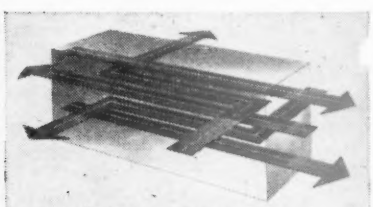

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ing requires positive motion regardless of conditions.

Other values of K, such as 1.25, 1.50, or 2.50 may be used where conditions warrant.

In cases where K=1, stem pull will be:

$$\overline{SP} = .262\,D^2\,P + 600d \quad \ldots\ (7)$$

In cases where K = 2, stem pull will be:

$$\overline{SP} = .524\,D^2\,P + 1200d \quad \ldots\ (8)$$

In cases where K = 3, stem pull will be:

$$\overline{SP} = .786\,D^2\,P + 1800d \quad \ldots\ (9)$$

Capacities of Gate Valve Actuators

Fig. 14 shows the loading conditions of an actuator, both at the valve and at the cylinder. The stem pull required to start and move the disc must be matched by an equal pull on the piston rod of the cylinder.

The theoretical piston rod pull of the cylinder:

Rod pull = p x a

When: p = pressure on the piston, lb per sq in.

a = area of the piston, on the rod end, sq in.

This value is theoretical as it does not allow for friction of cups, piston rings, or stem packings, nor does it allow for loss of pressure in ports and piping.

Table 1 gives the theoretical pulling capacity of cylinder actuators for gate valves at various operating pressures.

Selection of Gate Valve Actuators

With the stem pull required computed by formula (6), or one of its derivatives, it becomes a simple matter to select from Table 1 an actuator that has the

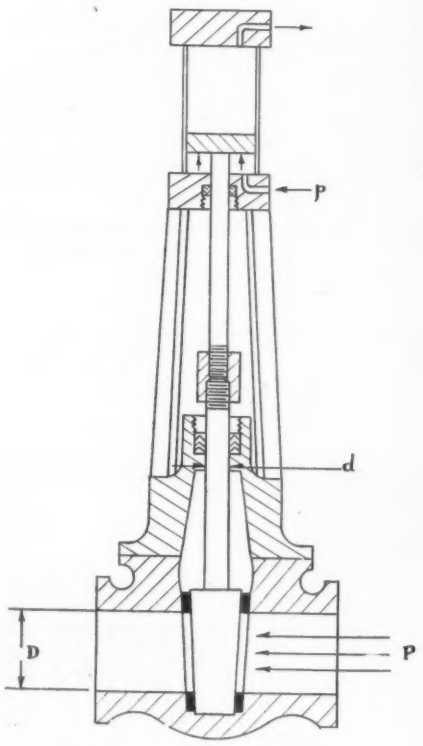

FIG. 14. Loading on gate valve.

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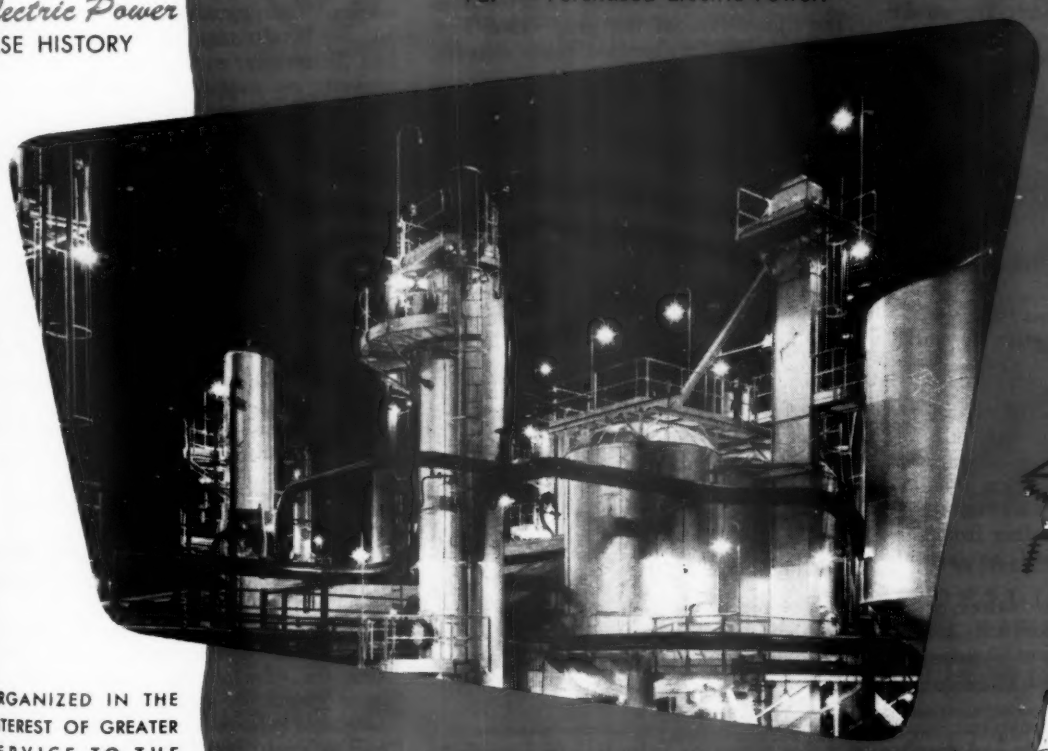

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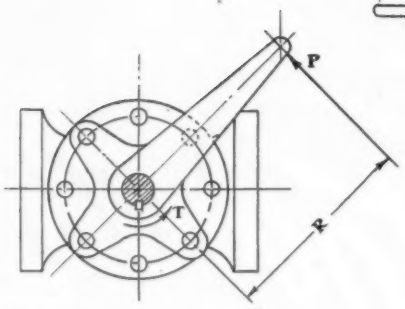

FIG. 15. Loading on plug valve—lever operated.

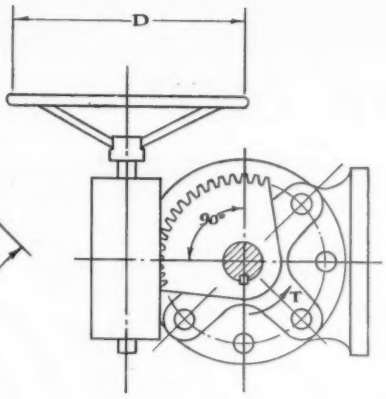

FIG. 16. Loading on plug valve—gear operated.

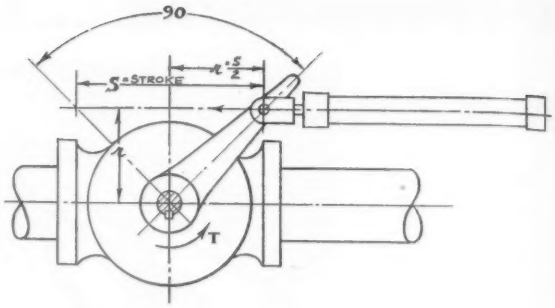

FIG. 17. Loading on plug valve with unit type actuator.

necessary pulling power. Since the values in the table are theoretical, and do not allow for friction or pressure losses, it is advisable to select an actuator about 25 to 50 per cent greater than the computed load.

Loads and Capacities for Diaphragm Valves

On diaphragm valves, the cylinders are connected to the stem in much the same manner as on gate valve actuators. There is a difference, however, in stroke length and in stem loadings.

The stroke length requirement for a gate valve disc is usually slightly more than the nominal valve size. The stroke length requirement for a diaphragm is much less because the diaphragm merely deflects and does not slide.

The stem loading on the diaphragm could be formulated as follows:

$$L = \left(\frac{\pi D^2}{4} \times P\right) F \quad . \quad . \quad . \quad (10)$$

Where:

D = diameter of the diaphragm opening in inches
P = line pressure in psi
F = factor due to friction in valve stuffing box and stiffness of the diaphragm

Due to the difficulty of determining the exact values of D and especially of F, the stem loading on the diaphragm does not lend itself as readily to calculation as that of a gate valve. It is, therefore, wiser to get such loading from the valve manufacturer based on actual valve tests.

As in the case of gate valves, it is proper to pick an actuator with a theoretical capacity about 25 to 50 per cent greater than the stem load.

Loads and Capacities for Plug Valves

In a plug valve, the power required for actuation is used to rotate a plug through an angle of 90 deg.

In a plug valve, as in a gate valve, the power to be provided must be sufficient to overcome the starting load and the moving load. As in a gate valve, these will depend on the design of the valve, the material of which the plug and body are made, the smoothness of finish, the accuracy of mating of plug in body, the fluid being handled, the extent of corrosion, etc.

It is very difficult to figure these from the dimensions of the plug valve. Fortunately, another method, much simpler, is available for the engineer.

Consideration of all of the variables is presumably included by the valve manufacturer in determining the length of lever required to turn the valve, even under adverse conditions. Since the effort available to pull on the lever is limited by the strength of the human arm, the length of the lever will give a good indication of the total torque required.

Fig. 15 shows the diagram of forces that act on a plug valve. The pull P is limited to about 35 lb for normal operation, but may increase to an ultimate limit of 200 lb under very severe operating conditions, such as heavy corrosion, frozen plugs, etc.

The torque on the valve stem in Fig. 15 would be:

$$T = PR$$

Where:

T = torque in inch pounds
P = pull on lever in pounds = 200 lb max. or 35 lb normal
R = length of valve lever

Therefore, the total torque that must be provided is:

$$T = 200R \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

On the larger valves, the torque required is so great that levers are impractical, and are therefore replaced by a gear train. Fig. 16 shows a plug valve operated by a gear train and wheel.

The effort P is applied to the handwheel having a diameter D, and its torsional effect is multiplied by the gear ratio and wheel radius. This ratio is, of course, 4 times the number of turns (N) required to open or close the valve, because the number of turns required results in 90 deg rotation of the stem.

The total torque on the plug will be:

$$T = P \times \frac{D}{2} \times 4N \times e$$

Where:

P = max. practical effort on handwheel = 35 lb
D = wheel diameter in inches
N = number of turns to open or close the valve
e = gear efficiency = 50 %

Therefore:

$$T = 35DN \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

These are practical, workable formulae, whereby we can select an actuator for plug valves, lever or gear operated, provided we can identify the valve in manufacturers' catalog.

Capacities of Plug Valve Actuators

Fig. 17 shows the loading conditions on a plug valve actuator, unit type, same as shown in Fig. 12.

When the cylinder pulls or pushes on the lever in extreme open or closed position, the effective lever arm is .707 X lever length R, and the effective component of cylinder action is .707 X piston pull or push. But this value is equal to one half of the total piston travel required, and consequently it can be said that:

$$T = P \times \frac{S}{2} \quad . \quad . \quad . \quad (13)$$

Where:

T = torque in inch pounds
P = total pressure on piston in pounds
S = stroke of piston in inches

TABLE. 1. Capacity of gate and diaphragm valve actuating cylinders in pounds.*

Cylinder diameter	Pressure of Operating Fluid in PSI							
	50	75	100	200	300	400	600	750
2"	135	202	270	540	810	1,080	1,620	2,020
3"	314	471	628	1,256	1,884	2,512	3,828	4,710
4"	567	850	1,134	2,268	3,402	4,536	6,804	8,500
6"	1325	1988	2,651	5,302	7,952	10,604	15,906	19,880
8"	2356	3534	4,712	9,424	14,136	18,848	25,272	35,340
10"	3681	5522	7,363	14,726	22,089	29,452	44,178	55,225
12"	5302	7952	10,603	21,205	31,809	42,412	63,618	79,520

*All figures given are theoretical and allowance should be made for friction, pressure drop, etc. Select actuator having theoretical capacity 25 to 50 per cent greater than stem pull or push.

The torque capacities of single cylinder actuators have been computed for certain diameters and stroke lengths, for various pressures, and are listed in Table 2.

The single cylinder actuator, also known as "unit type actuator," shown in Fig. 17, requires an outside support for the cylinder, which is not always available, and flexible hose connections. In many cases, the actuator must be mounted on the valve itself without any outside support and rigid piping is desired. The tandem type actuator shown in Fig. 6 and Fig. 9 meets these requirements and, due to its balanced construction, eliminates unbalanced load on valve bonnet.

In the tandem type actuator, two cylinders are effective simultaneously. The loading conditions are the same as in Fig. 17, except that the torque is double that of the unit type actuator. Therefore:

$$T = 2PS \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

The torque capacities of tandem type actuators have been computed for actuators with certain standard cylinder diameters and stroke lengths, for various pressures, and are listed in Table 3.

Selection of Plug Valve Actuators

With the required torque computed from Formula (11) or Formula (12), it becomes a simple matter to select from Table 2 or 3 an actuator that has the necessary torque capacity. Since the values in the tables are theoretical, and do not allow for friction or pressure losses, it is advisable to select an actuator about 25 to 50 per cent greater than the computed load.

For automatic safety installations, it is advisable to use a larger actuator, and a factor of 1½ is suggested. In other words, the actuator for a safety installation should be about 50 per cent bigger than for a normal operating installation.

Safety Installations

All of the actuator selections given above, whether the sliding type as in gate valves or the turning type as in plug valves, apply to opening or closing under power, when such power is available.

TABLE 2. Torque ratings of unit type valve actuators—in inch pounds.*

Actuator number	Size of cylinder	Operating Pressures in PSI			
		50	100	200	400
2U6	2 x 6	400	800	1,600	3,200
2U12	2 x 12	800	1,600	3,200	6,400
2U18	2 x 18	1,200	2,400	4,800	9,600
3U6	3 x 6	940	1,880	3,760	7,520
3U12	3 x 12	1,880	3,760	7,520	15,040
3U18	3 x 18	2,820	5,640	11,280	22,560
3U24	3 x 24	3,760	7,520	15,040	30,080
4U12	4 x 12	3,400	6,800	13,600	27,200
4U18	4 x 18	5,100	10,200	20,400	40,800
4U24	4 x 24	6,800	13,600	27,200	54,400
6U12	6 x 12	7,950	15,900	31,800	63,600
6U18	6 x 18	11,925	23,850	47,700	95,400
6U24	6 x 24	15,900	31,800	63,600	127,200
6U36	6 x 36	23,850	47,700	95,400	190,800
8U12	8 x 12	14,125	28,250	56,500	113,000
8U18	8 x 18	21,185	42,375	84,750	169,500
8U24	8 x 24	28,250	56,500	113,000	226,000
8U36	8 x 36	42,375	84,750	169,500	339,000

*All figures given are theoretical and allowance should be made for friction, pressure drop, etc. Select actuator having theoretical capacity 25 to 50 per cent greater than torque requirements.

TABLE 3. Torque ratings of tandem type plug valve actuators—in inch pounds.*

Actuator number	Size of cylinders	Pressure of Operating Fluid in PSI					
		50	75	100	200	300	400
2TA8	2 x 8	1,165	1,745	2,330	4,660	6,990	9,320
2TA12	2 x 12	1,750	2,625	3,500	7,000	10,500	14,000
2TA18	2 x 18	2,625	3,935	5,250	10,500	15,750	21,000
3TA12	3 x 12	3,975	5,950	7,950	15,900	23,850	31,800
3TA18	3 x 18	5,950	8,925	11,900	23,800	35,700	47,600
4TA18	4 x 18	10,700	16,050	21,400	42,800	64,200	85,600
4TA24	4 x 24	14,275	21,410	28,550	57,100	85,650	114,200
6TA18	6 x 18	24,500	36,750	49,000	98,000	147,000	196,000
6TA24	6 x 24	32,700	49,050	65,400	130,800	196,200	261,600

*All figures given are theoretical and allowance should be made for friction, pressure drop, etc. Select actuator having theoretical capacity 25 to 50 per cent greater than torque requirements.

For safety installations, however, such power is not always available, as in many cases it is required to operate the valve when power fails or a line breaks, and in these cases, an auxiliary reserve source of power must be utilized. Pneumatic actuators with auxiliary pressure tank acting as accumulator are particularly recommended for such installations.

Fluid Pressure for Actuators

The stem pull or torque capacity of actuators varies directly with the pressure applied to the cylinders. Hence, for any given stem pull or troque requirement, the size, and therefore the cost, of any actuator required will reduce as the operating pressure is increased, and will increase as the operating pressure decreases. This can be illustrated more clearly by a specific example.

An actuator was calculated for a 24-in. gate valve (D) in a water filtration plant. Line Pressure (P) is 35 psi. Diameter of Stem (d) is 2 in. Service Factor (K) for such a plant is (1).

$$\text{Stem pull by formula (7)} = SP = (.262D^2P + 600d)K$$
$$= (.262 \times 24^2 \times 35 + 600 \times 2) \times 1 = 6450 \text{ lb}$$

In selecting an actuator, an additional factor of 25 to 50 per cent should be imposed for actuator losses. Assuming this to be 1.4, the theoretical stem pull capacity required is $1.4 \times 6450 = 9000$ lb.

This capacity may be obtained from a number of different combinations of operating pressures and cylinder diameters.

(1) If the actuator is operated by 35 psi water pressure from the main line, the piston area required is $\frac{9000}{35}$, or 257 sq in., corresponding to 18-in. diameter, and call-

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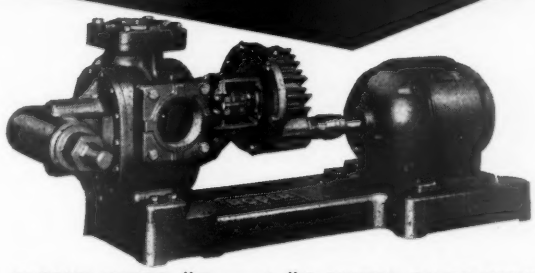

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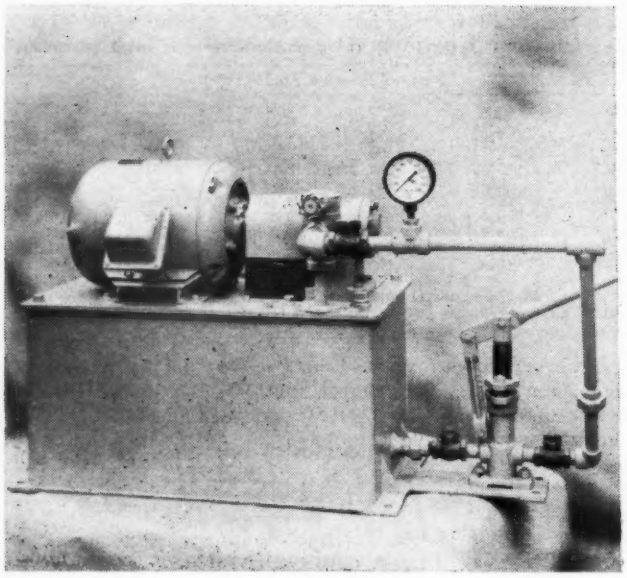

FIG. 18. Hydraulic power unit for actuators. It consists of motor, coupling, pump, relief valve, filter, pressure gage, and hand pump for emergency operation.

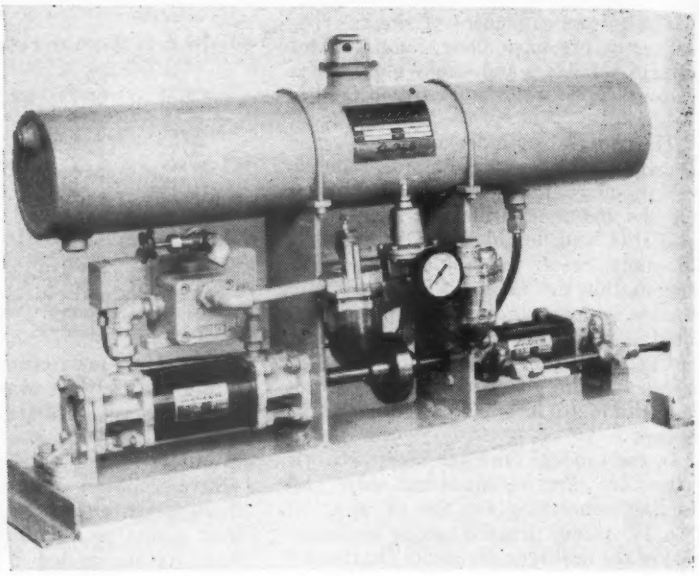

FIG. 19. Air-hydraulic power unit for valve actuators. Power is delivered from air compressor to a reciprocating air-cylinder motor, opeating a hydaulic cylinder.

ing for about an 18-in. by 25½-in. actuator.

(2) If the actuator is operated by air at 80 psi pressure, instead of by low pressure water, the piston area required is $\frac{9000}{80}$, or 112 sq in., corresponding to 11.4-in. diameter, and calling for about a 12-in. by 25½-in. actuator.

(3) If the actuator is operated by water or oil at 400 psi pressure, instead of by air or low pressure water previously considered, the piston area required is $\frac{9000}{400}$, or 22.5 sq in., corresponding to 5.4-in. diameter, and calling for about 6-in. by 25½-in. actuator.

While costs of equpiment vary from time to time and from manufacturer to manufacturer, they nevertheless maintain a certain proportionate ratio which may be used for comparison purposes in studying relative merits of design. In this case, the relative values, based on cost estimates, are as follows:

1. 18 by 25½ actuator at 35 psi — $2000 (installed on gate valve)
2. 12 by 25½ actuator at 100 psi — $1200 (installed on gate valve)
3. 6 by 25½ actuator at 400 psi — $400 (installed on gate valve)

A substantial saving is indicated by selecting an actuator at higher pressure, but this cost is offset sometimes in part, and sometimes to a prohibitive extent, by the cost of the equipment for delivering the higher pressure.

Much depends also on the number of actuators to be used, for the cost of the pressure source must be divided by this number for comparison purposes.

For the 24-in. gate valve described we would have:

Case (1) — no auxiliary pressure source (pump) is required.

Case (2) — an air compressor would be required. For operation of one valve actuator only, a small compressor costing $250 to $350 would be more than ample and the total cost of actuator plus compressor becomes attractive. If a number of actuators are to be considered in one group, then, of course, the addition of one compressor to a group of actuators becomes definitely very economical. even if a larger compressor, costing from $500 to $800 is to be purchased.

Case (3)—an hydraulic pumping unit is required. The cost of such a unit, according to type and size, will vary from $500 to $1200, and again, the addition of such a power unit may be considered efficiently for use with one large actuator. If the number of actuators in one group is more than three or four, then the addition of the power unit will definitely result in great saving.

A study was made on a complete water filtration plant using 48 actuators of various sizes. It showed a cost of $65,000 for all actuators and control vales at 35 psi water, and a cost of $35,000 for necessary actuators operating at 400 psi and powered by air-hydraulic pump and air compressor, including a complete "stand-by" power plant. Such a saving is certainly worthy of serious consideration.

Pumps for Higher Pressure

Air compressors can be had to deliver air pressure at 80-150 psi. When using such compressors, it is well to remember that the gage pressure at the compressor is not the same as the pressure applied to the cylinder, since there are always line losses, and these may be considerable.

Many types of standard power units for producing higher pressure are available on the market.

Hydraulic pumps and power units are made by a number of manufacturers, and will deliver pressures from 100 psi to 3000 psi. One such power unit is shown in Fig. 18.

This unit was built especially for valve actuators, and delivers oil pressure at 400 psi. It consists of a motor, coupling, pump, relief valve, filter, pressure gage, and hand pump.

The hand pump was inserted in the line to make possible the operation of the actuators in the event of pump or power failure. It serves an additional purpose in making possible more pressure than the motor pump can deliver in the event of valve "freezing", a contingency which happens frequently in this particular plant due to the nature of its operations.

Another power unit very efficiently used for operation of valve actuators is shown in Fig. 19. This unit is powered by air or natural gas rather than an electric motor.

Power is delivered from the air compressor to a reciprocating air-cylinder motor, operating a hydraulic cylinder. Unit is equipped with oil tank, oil and air filters, air lubricator, silencer, and air pressure regulator.

Oil pressure to actuators can be adjusted to exact value required by means of air pressure regulator. Thus, pump will deliver only required pressure for all normal operations, but will give additional pressure for emergencies by simple adjustment of air pressure regulator.

Summary

Use of power for operation of valves is indicated for cost savings, for remote control, for automatic operation, and for safety shut-off.

Cylinder actuators are available of standard manufacture and known capacity. They may be readily installed and are economical both in first cost and in operation.

Hydraulic or air-hydraulic pump can reduce the installation and operation cost, especially on larger valves or groups of valves in one vicinity.* * *

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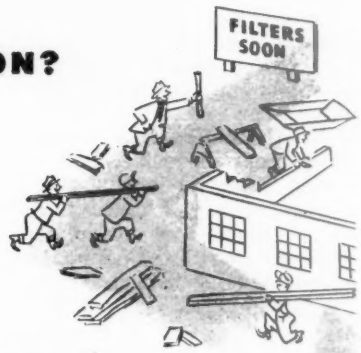

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Petroleum Profile

HARRY WESLEY BASS might have become a banker, considering his philosophy that a man should save more than he spends. But because of a check cashed by a tool dresser at a bank window where youthful Bass was cashiering, his entire future was changed some 34 years ago.

Returning from military service after World War I, in which he spent two years with the field artillery, young Harry Bass decided upon a financial career. The biggest houses in his hometown, he noted, were occupied by bankers, who also drove the town's fanciest teams.

He considered himself rather fortunate, working as paying and receiving teller in a local bank in Enid, Oklahoma. Around noon one day in 1919, an oilfield worker entered the bank and shoved his check through the window. Bass took a second look at the amount of the check and noted the inscription, "Wages for tool dressing."

He quickly compared the amount with his earnings in the bank for the same period of time. The decision he made that afternoon was a monumental one in his life. He decided to get into the oil business.

Fortune struck twice that day. Notifying the president of the bank that he was leaving the first of the month for the oil fields, Bass walked out of the building and found destiny just across the street. Destiny was in the form of H. H. Champlin, a grizzled, kindly-eyed oilman, banker and industrialist who looked up at his approach.

Bass and Champlin made a deal, with Harry becoming office boy for the firm, Champlin and Winkler Drilling Company. In a brief time, he became manager of the firm's warehouse and boarding house for drilling crews at Ranger.

Fortune continued to smile on the youthful Bass. Meeting his boss, L. A. Winkler, on the road one day as he carried back a load of groceries, he found Winkler on his way to Enid to help form a corporation with Champlin. Harry thought fast. "Takes three to form a corporation, doesn't it?" he asked. Two weeks later he became a five per cent owner, his first proprietorship.

It wasn't long before Harry was caring for five rigs. And he was still following the philosophy developed as a boy of saving more than he spent. In a few more years that reasoning paid off well. The partnership of Champlin and Bass was formed when Winkler became inclined to ease off, and the new partnership obtained leases and began producing.

A development even more important than the new production came into Bass' life about this time. Traveling between Enid and the new fields, one goes through the city of Chickasha, and that's where pretty Wilma Schuessler lived. Their marriage in October, 1925, was another milestone.

HARRY W. BASS
President
Wilcox Trend Gathering Systems, Inc. and Goliad Corporation

Headquarters for the firm moved to Holdenville, where business continued to increase, more tools were acquired and money made.

In 1932, Bass moved his family to Dallas and set up offices in the Magnolia Building, from where he could keep a watchful eye on operations in five states. The family by then included Harry, Jr., and his younger brother, Richard Daniel.

In 1939, Bass and Champlin formed the Trinity Gas Company and built a cycling plant in the Long Lake field. Two more plants in which the new firm had ownership were later built at the Sejita and Grapeland fields.

Canada's new Princess field opening in 1941 drew rigs from Bass, which subsequently led the organization of the Can-Tex Drilling Company, Ltd., of Canada. The firm has twelve rigs operating there now. When Champlin died about six years ago, Harry acquired complete ownership of the drilling equipment.

Many other accomplishments can be chalked up on Harry's record. In 1938, he originated and had built the first A-frame portable drilling mast. The unit, made by Lee C. Moore Company, is still in use.

He was also instrumental in causing the Sejita gas field of Duval County, Texas, to be the first gas field ever unitized on an acre foot basis.

In 1952, Bass became president of Wilcox Trend Gathering System, Inc.

After 34 years as an active contractor and producer in the oil and gas industry, Harry Bass can now relax on his 6000-acre ranch where prize Herefords and Tennessee walking horses graze. The pleasant oilman also finds relaxation in dove hunting in season and deepsea fishing in the Gulf.

The pioneer spirit is much a part of Harry's life, as are competition and adventure. He was born in 1895 near Enid, Oklahoma, the third child of seven. His Canadian-born father, Daniel Christopher Bass, participated in the Cherokee Strip race in 1893 and won a quarter section of land. The elder Bass later sold his land and moved to town, becoming a successful building contractor.

Harry attended the University of Oklahoma, staying there until World War I broke out in 1917. He entered the army, attended Officer's Training School at Leon Springs, Texas, and served in the artillery for two years.

A firm believer in education, he has established scholarships at the University of Oklahoma, and in the high school at Edmonton, Ontario, Canada, both of which foster good citizenship.

Harry W. Bass is proud of the oil industry of which he is a part. And he sees plenty of oportunity for today's young people in it.

IN THIS ISSUE—

PRESSURE MAINTENANCE

In order that production rates might be maintained at a level compatible with market demand without an excessive infill drilling program, and to insure lifting from 6800 ft with a minimum of investment and operating difficulty, the described program for maintaining reservoir pressure through water injection was inaugurated. The Tensleep reservoir developed in the Steamboat Butte field contains some 175,000 net acre feet of oil sand underlying 1135 productive acres. Recovery since discovery in March, 1944, from the 19 producers was roughly twelve and one-half million barrels through the middle of 1953. Ample evidence of the limitations in the existing natural water drive justify the injection program from the standpoint of reduced development and lifting costs and maintenance of productivity at a high level.

ENGINE COOLING

With engine costs elevated as all other equipment costs, it is highly desirable that they be operated in such a manner that their maximum power capabilities are fully developed. Mr. Freeman shows that thermal efficiencies under normal circulated water cooling are not as high as is desirable and points out further the experiences of lowered maintenance cost he has witnessed. The utilization of what is now an undesirable byproduct of engine operation, heat, for the comfort and convenience of operating personnel is also discussed.

IMPEDIMENT TO FLOW INTO WELL BORE

The so-called "skin effect," the result of invasion and plugging of producing formations in the immediate vicinity of well bores, has undoubtedly contributed to the early abandonment, with subsequently lower ultimate recovery, of many producing wells, and to the abandonment as dry holes of others where core analysis and electric logs indicated commercial shows. We here present a factual report of this condition with the mathematical analysis leading to the establishment of the magnitude of the involved forces and their results on recovery rates and indicated productivity indices.

PEAK TORQUE LOAD REDUCTION

Overloaded reducers on pumping units fail early, causing unnecessary maintenance and replacement expense. Accepting that at best initial loading and counterbalancing calculations are but approximations, the need for physically measuring settled pumping loads becomes apparent. Then counterbalances may be properly adjusted, peak torque loads smoothed, and the prospects for long life and trouble-free operation of reducers enhanced.

POZZALANIC CEMENTS

Mixing Pozzalan, a siliceous material of volcanic origin, with a portland cement imparts qualities to the product that are highly desirable in some applications. Shattering around perforations is reduced, pumpability is improved, permeability of product is low, and resistance to leaching or alteration by ground water is increased. The Prentice field in West Texas produces from the Glorietta zone, which is immediately overlain by sulfur-water bearing San Andreas lime. The characteristics exhibited by the Pozzalanic cement mixtures are particularly desirable and their use has met with considerable success in reducing completion costs and squeeze and reperforate requirements.

NEW DEPTH RECORD

Ohio moves ahead in its assault on the depth frontier, having reached and passed Superior's existing record of 20,521 set in 1949 in Sublette County, Wyoming. Shown are some of the men and equipment used in breaking the established record and moving on to new depths. More views are shown in a special pictorial section being added this month.

CASING LANDING MATERIALS

Your discussion is invited. True, there are only three things you can do when you nipple up — stretch the pipe, slack it off, or leave it as cemented. We offer competent discussion of all three and elect the latter. Be glad to get any comments you may have though.

AND —

A little resumé on oil base muds. They have been used in the three deep ones, below 20,000 ft that is, with considerable success. Also offer advantages over standard water-base mixtures in some shallower areas. No trouble to handle if your equipment is right. . . . Couple of operating stories too. C. D. Allen was mud engineer on a deep West Texas test and used some theories on pH control with good luck. Out in Nebraska a successful completion followed a penetration offsetting a dry hole with mud control getting credit for the success. Might be a practical application of "skin effect" as discussed in Hurst's article in this issue . . . Thurman Green points out some of the highlights of Sun's experiences in safety and well qualified he is to do it too. If the industry safety record could be raised to Sun's level we could knock those compensation premiums way below 10 per cent. . . . Offshore barges get notice too. Vibration from big pumps and big engines can get mighty wearisome after a few days and nights of steady treatment. Rubber isolators and minor changes in structure look good as a cure.

BAKER

now offers not one, not two, but THREE ranges of

Hinge-Lok Casing Centralizers

. . . with increased reach (bowed height) of springs to provide AMPLE ALL-AROUND cementing space for ALL casing programs, and VARYING hole sizes and conditions, PLUS unsurpassed convenience and ease of installation.

BAKER MODEL "H"
20 Range HINGE-LOK
Casing Centralizer

PRODUCT NO. 9112

Recommended where LESS-THAN-NORMAL CLEARANCE exists between the casing ON which the centralizers are mounted and the casing THROUGH which the centralizers are run. If the formation is such as to create special problems of over-size or irregularity of the open hole, it is often advisable to run the "H-20" Centralizer on the first few joints—for ease in starting—followed by the "H-25" or the "H-50" Super-Range Centralizer.

BAKER MODEL "H"
25 Range HINGE-LOK
Casing Centralizer

PRODUCT NO. 9113

Recommended where NORMAL CLEARANCE is present, and no serious problem of over-size hole is anticipated. The "H-25" Centralizer is recommended where conditions are such that starting force would be a problem with the "H-50" Super-Range Centralizer, in which case the H-25 might be used on the first few joints and the H-50 run above it. Although the H-50 requires a larger spacing interval for easy starting than the H-20 or the H-25, fewer "H-50" Centralizers—with their superior reach—ensure even greater effective centering force.

"Reach" (Bowed Height) is vital factor

All Baker HINGE-LOK Casing Centralizers have greater reach (or bowed height) of springs in corresponding ranges than any other casing centralizers on the market.

Increased reach means adequate, all-around cementing space even though the hole size varies considerably from the drill bit size. Without this increased reach, it is quite probable that casing may contact the wall of the hole between centralizers resulting in a poor cement job at that point.

Hinged for easy mounting

Baker HINGE-LOK Casing Centralizers can be *installed in a matter of seconds* while running-in, as *no welding is required*. Just close the HINGE-LOK Centralizer *around a coupling* and then insert drive nails which *thread themselves* into the hinge knuckles, and *will not come out*. When exact spacing is desired, easily installed Stop Rings can be plug-welded at required positions.

Maximum effective centering force

Baker HINGE-LOK Casing Centralizers provide the most uniform annular cementing space around the casing. And this cementing space is present regardless of repeated flattening of the springs in a deep well, or of off-vertical condition of the hole.

The engineered bow shape of the springs, with an ideal relationship between the length and the bowed height of the springs, provides *greater landed centering force* than can be obtained from any other available hinge-type centralizer covering the same range of hole sizes.

All springs work together

All of the powerful springs of Baker HINGE-LOK Casing Centralizers work together to offer a combined positive resistance against any tendency of the casing to contact the wall of the open hole. As the springs are forced toward the casing by contact with the wall of the hole, their effective length is decreased, thereby stiffening them and increasing their resistance to further deflection.

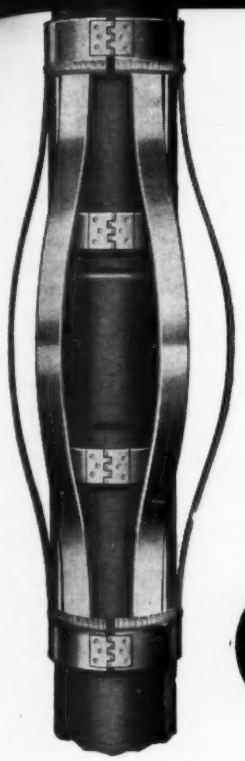
Unlimited rotation of casing

Whether Baker HINGE-LOK Casing Centralizers are installed around couplings or over a standard Stop Ring, the casing can be freely rotated without rotation of the centralizers.

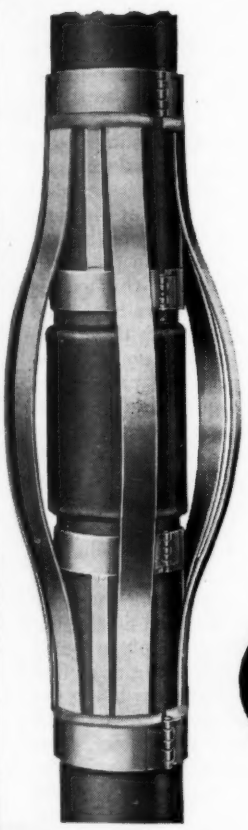
Easy starting without snubbing

The superior spring design of Baker HINGE-LOK Casing Centralizers assures easy starting without sacrificing the powerful centering force delivered after full down-hole travel of the casing. By following the easily read "Starting Force Spacing Guide," all need for applying external starting force is eliminated even in relatively close-tolerance programs.

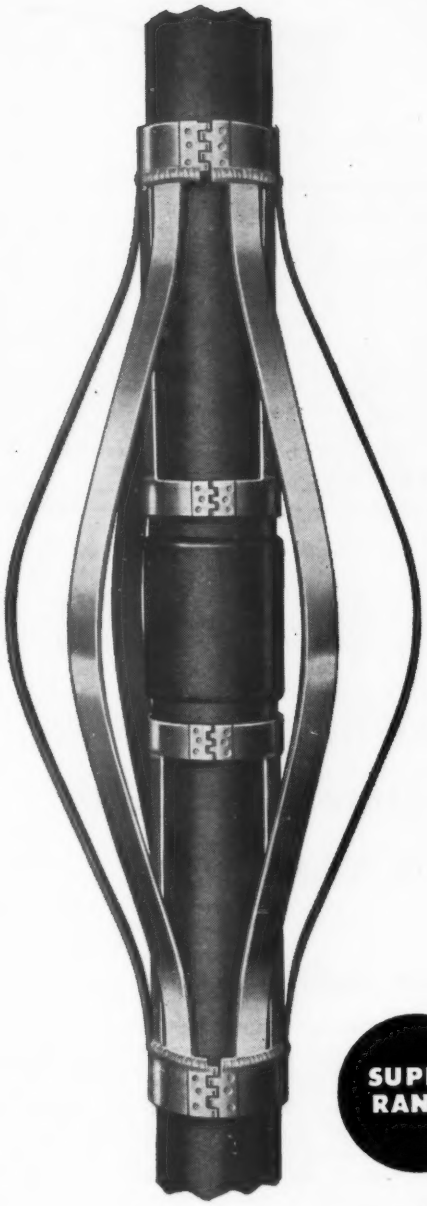
XUM



20 RANGE



25 RANGE



SUPER-RANGE

BAKER MODEL "H-50"
Super-Range HINGE LOK
Casing Centralizer

PRODUCT NO. 9114

Recommended for GREATER-THAN-NORMAL CLEARANCE—wherever the diametral clearance between the casing ON which the centralizers are mounted, and the casing THROUGH which they are run exceeds five inches, or for NORMAL CLEARANCE where extensive hole irregularities are anticipated. No other centralizer can provide such effective centering action as the "H-50" in *irregular or over-size hole sections, or in cavities.* By increasing the bow of the springs (without proportionately increasing their resistance to starting) maximum centering efficiency is assured, regardless of individual well conditions.

BE SURE YOU GET

Maximum Centering Force

THROUGHOUT THE ZONE
TO BE CEMENTED

Always *pulled*—never pushed

Baker HINGE-LOK Casing Centralizers are always "pulled" during upward or downward travel of the casing in the well. This feature is important when the centralizer passes through any tight spots in the hole—and is especially advantageous when reciprocating casing during cementing operations.

Call Baker for Centralizer service

Any Baker representative, or office, is ready to give you the kind of service every operator appreciates—sincere, courteous assistance to help you get successful "first-time" cementing results.

BAKER OIL TOOLS, INC.

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XUM

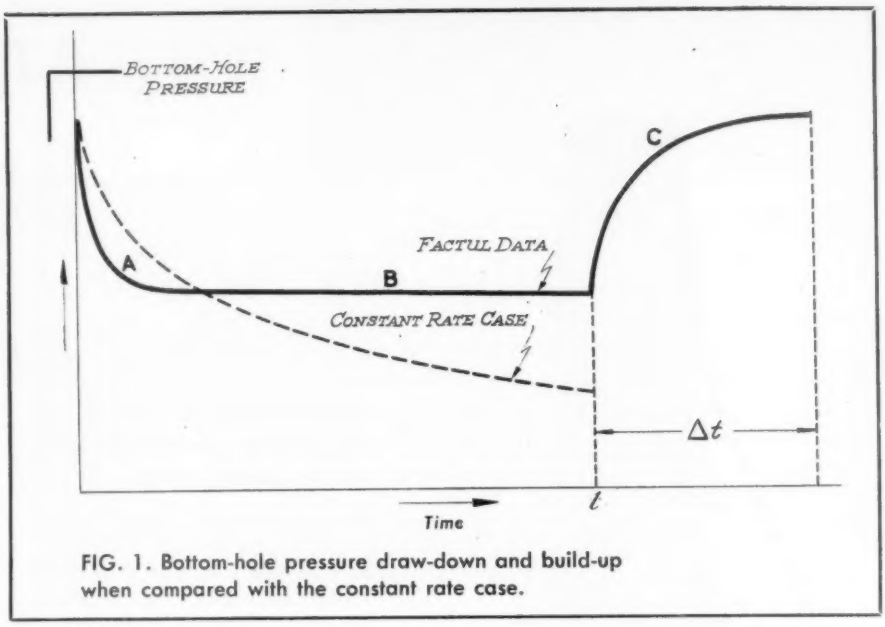


FIG. 1. Bottom-hole pressure draw-down and build-up when compared with the constant rate case.

Establishment of the Skin Effect and Its Impediment to Fluid Flow Into a Well Bore

WILLIAM HURST

Early in 1944, and engaging his attention for several years afterwards, the author has attempted to explain marked incongruities that appear in the pressure behavior of draw-down and build-up curves indicated by a bottom-hole pressure gage in a flowing well followed by a period of shut-in, when compared with the theoretical aspects of fluid flow into a well. In this connection considerable effort was spent in developing new concepts to relate the various boundary conditions to explain these inconsistencies. What has been revealed resolves itself as a "damaged" sand condition, which exists in the immediate, or the adjacent areal extent in the sand close to the well bore, whose permeability is greatly reduced from that of the formation proper. This causes a discontinuous and larger pressure drop to occur in this region than that indicated by ordinary fluid flow mechanics familiar to most petroleum engineers. This is the skin effect, which will be discussed in this paper, and although this investigator realized early in his study that the presence of this impediment no doubt limits the life of producing wells, he has been more concerned with wells abandoned as dry holes where the electric log, as well as core analyses showed the possible existence of commercial production and may have been caused by this effect. It is not the purpose of this paper, however, to enter into a discussion as to remedial innovations in well completions to overcome this situation, but merely to report this condition as supported by factual data, that the industry may be cognizant of its existence.

To review briefly the recognition of this restriction at the well bore: It was considered that a draw-down bottom-hole pressure curve should in effect be reproduced by the theoretical consideration of a constant rate problem in a transient state.† Actually in the comparison of well data, the idealized conditions indicated by this phenomenon could never be realized in practice. What has been observed from innumerable flow tests, and illustrated in Fig. 1, was that the theoretical deduction implied by this constant rate case showed a continuously cumulative pressure drop with time, whereas the actual pressure draw-down showed a rapid pressure change in early times. It then leveled off to a uniform flowing pressure with increased time, which the reader will recognize to be the value employed for the determination of the productivity index for a well when associated with its rate of production.

This marked departure from theory has resulted in the development of many different well boundary conditions, and later abandoned as their application showed an incompatibility with the physical data at hand. In brief, the procedure employed was essentially that of a "trial and error" method, in which valid mathematical interpretations were readily set aside unless supported by the information available as indicated by the bottom-hole pressure gage. As a result of this work two profound observations were evidenced, which when reviewed now in the light of the pressure draw-down and build-up curves are self evident. At the time of their early development, however, these were only surmises. Subsequently, much of these concepts have been presented to the industry by the many public talks to technical groups requested of the author and his former associate,‡ although the analytical developments hereto have not been presented.

One of these observations is implied in the meaning of the theoretical constant rate problem. In this case, it is assumed that the formation is one of uniform sand conditions, extending from the well to large distances removed in the reservoir, and from the instant the well is opened to production the rate of fluid entry into the well bore from the formation proper is constant, and remains constant for the entire period of production. Although this is the condition observed at the separator and stock tank from the time the fluid reaches the surface, it is not the condition that exists in the formation next to the well bore. As further consideration will reveal that the mechanical condition of a well is such, with the tubing suspended within the casing, that at the instant of opening the wing valve, the initial production is the unloading of the annulus to displace the oil in the tubing. This unloading is at first very rapid, and is shortly retarded by the stabilization of the bottom-hole pressure. Concurrent with this effect, however, the actual rate of fluid entry into the well from the formation is initially zero, but rapidly increases to reach the constant rate when such stabilization occurs. The composite effect of the two phenomena is the constant rate of production observed at the surface, which is controlled by the choke in the flow stream. Thus, the assignment of the fluid influx into a well bore is a variable rate problem, which depicts the pressure decline in early times as indicated by Curve "A" in Fig. 1, as it differs from the theoretical constant rate problem.

†The varying bottom-hole pressure for a constant rate problem in an infinite uniform medium is developed in the paper entitled, "The Application of the Laplace Transformation to Flow Problems in Reservoirs," by A. F. van Everdingen and W. Hurst, Transactions of the AIME, 1949 as given by Eq. IV-11, and for which the necessary work curves are produced. This relation is sometimes referred to as the Lord Kelvin Equation, although not strictly in its true sense, as the two equations are identical only when times are large.

‡In this connection it is to be mentioned that this work has been the joint enterprise of the author and A. F. van Everdingen[2] of Shell Oil Company.

EXCLUSIVE

This is the first observation noted between theory and actual performance, and although there are other facets to this phase of the problem, such as fluid standing in the tubing, for which empirical deductions have been developed to relate the entry of oil into the well bore, the essential point is that this is a variable rate and not a constant rate problem in early times of pressure drawdown. In later times, however, when the rate of fluid flow into the well becomes fixed, the solution for this problem and the idealized constant rate become identical. Such a variable rate problem has been presented in the earlier paper[1] on the Laplace Transformation, where the rate of fluid entry is expressed as a function of bottom-hole pressure decline, and although the skin effect is not included in that analysis, its counterpart is given in the present text.

This brings us to the second observation, namely the skin effect, or the impediment to fluid flow into the well. There has been considerable conjecture in this investigation as to why the observed bottom-hole pressure levels off as illustrated in Fig. 1, and the constant rate application for a uniform sand shows a continuous pressure decline. This has entailed a great deal of time and effort to foresee the answer, but what became evident as this work developed is that there is some impediment close to the well bore, which because of its large resistance to fluid flow, can completely "mask" the increment in pressure drop incurred in the formation proper indicated in the constant rate problem.

To clarify this point for the reader: If it is supposed that around the well bore a restriction to fluid flow exists, which is of a lower permeability than the formation, then under conditions of flow, the total pressure drop from the formation to the flowing well pressure would consist of the sum for the drop in pressure within the formation, plus the drop in the restriction for the fluids entering the well. As the bottom-hole pressure levels off, however, Curve "B," Fig. 1, instead of reproducing the steady pressure decline of a constant rate problem for a uniform sand, implies that a restriction must exist, and that the order of magnitude for the pressure drop due to this impediment must be greater than the pressure drop in the sand proper to retard the pressure decline to the extent observed. Furthermore, as all these concepts are postulated on transient state where pressure varies with time, the fact however, that the bottom-hole pressure remains fixed as indicated by the data, means that the impediment must be a function of rate, and independent of time.

As a further explanation for this latter observation, the author has developed an original treatment for the unsteady state fluid flow problem in a radial system, composed of two sands of different permeabilities in series, which will be published elsewhere. In this formulation is is significant that when the region of lower permeability next to the well is of finite extent, the pressure drop due to the impediment is a function of rate and time. When this impediment, however, is restricted to the well bore, this value is a constant that is dependent only on the rate of fluid flow, and lends validity to the thought already expressed in referring to this restriction as a skin effect. This skin effect can only be ascribed to as a damaged sand condition at the well bore.

The Author

William Hurst is a partner in the firm of Petroleum Consultants, Houston, Texas. One of the early reservoir engineers in the industry, Hurst is a graduate of Massachusetts Institute of Technology, where he received both his BS and MS degrees. From 1929 to 1941 he was employed in production research by the Humble Company, followed by an association with Core Laboratories, Inc., from 1942 to 1943. He was senior reservoir engineer for Shell Oil Company until 1948, going into private consulting practice before joining Petroleum Consultants.

Mathematical Development

As previously mentioned, it is not the purpose of this paper to present remedial measures to overcome the skin effect, but to offer the analytical tools that would permit the determination of this impediment. In this respect the publication is of a more general scope and a means of comparison for various well completion practices. Therefore, it is essential to enter into a mathematical discussion of the skin effect, such that its engineering interpretation can be readily applied.

The mathematics employed are stipulated on the diffusivity equation for the unsteady state fluid flow,[3] and refers to a slightly compressible fluid encountered in an undersaturated formation or reservoir crudes close to the saturation pressure. Further, under certain conditions the analytics are likewise applicable to the flow of gas in a formation, provided that the pressure drop between the static and flowing bottom-hole pressure is not excessive with reference to the former. Although such limitations have been imposed, it is considered that even for a two or three phase fluid flow those interpretations can be applied in an empirical if not in a rigorous fashion.

Based on these considerations the following presentation gives the logic for computing the skin effect from bottom-hole pressure build-up data: If the rate of fluid flow into a well bore is constant, and an impediment such as the skin effect exists, the cumulative pressure drop between static and flowing bottom-hole pressure is expressed, as previously mentioned, as the drop in pressure in the formation proper plus that incurred by the skin effect. This is given as

$$\Delta P = q(t)\,[S + P(t)] \quad . \; . \quad (1)$$

Where $P(t)$ is the drop in pressure in the formation, referred to the interface next to the impediment, and S is the drop in pressure across the skin effect, when associated with the fluid influx into the well bore $q(t)$. Further,

$$q(t) = \frac{q(T)\,\mu}{2\pi KH} \quad \text{and} \quad t = \frac{KT}{f\mu c R_b^{\,2}}$$

The units and symbols employed are identical with those previously given in Laplace Transformation,[1] in order to provide continuity and to facilitate the understanding of the subject matter for the reader. Thus, the term $P(t)$ is the constant rate case given in Eq. IV-11 of that paper for a uniform sand, and when time is large, such as $t \geqslant 100$, which is within the scope of application in bottom-hole pressure studies,

$$P(t) = \frac{1}{2}\,[\log t + 0.80907] \quad . \; . \quad (2)$$

referred to as Eq. VI-15 in the earlier publication[1]. The logarithmic term indicated in this formulation is the natural logarithm, and will be used throughout this presentation. The term S, a new symbol, is the skin effect and dimensionless.

The units used are related to D'Arcy's equation, in which the cumulative pressure drop ΔP is given in atmospheres, the rate of well production $q(T)$, corrected to reservoir conditions, is in cubic centimeters per second, the permeability K in darcys, the sand thickness H in centimeters, the time T in seconds, the porosity f a fraction, the viscosity μ in centipoises, the compressibility c expressed as volume per volume per atmosphere, and the well radius R_b given in centimeters. The term t is dimensionless time.

From a practical consideration, and indicated in Eq. 1, the reader will note that S bears a close analogy to productivity index, that is often referred to in the industry to express the productive capacity of a well, as barrels per day production per pound per square inch, in pressure drop. In the notation given in this formula, where $P(t)$ is negligible, the productivity index can be symbolically stated as

$$\text{Productivity Index} = \frac{2\pi KH}{S\mu} \quad . \; . \quad (3)$$

which is directly proportional to the sand capacity and indirectly proportional to the skin effect. We shall have occasion to refer to this expression, because when the bottom-hole pressure stabilizes to indicate a productivity index, the cumulative pressure drop can be, to a large degree, the result of this skin effect, and to a much lesser degree the pressure drop incurred in the formation itself. It can be mentioned from the interpretation of Eq. (3), that when the skin effect is large the productivity index is low, but on the other hand if the sand capacity is likewise large the productivity index can be appreciable, which are factual examples observed in everyday well performance. In this respect, the

skin effect can more readily impair the commercial production from a well producing in a tight formation than for a well producing from a larger capacity sand.

Before developing the superposition theorem for the entire performance of a draw-down followed by the bottom-hole pressure build-up curve shown in Fig. 1, the variable rate problem that exists in early times will be discussed briefly, incorporating the skin effect. It has been shown in the paper cited[1], that when the rate of flow into a well bore is a variable due to the unloading of the annulus, the cumulative pressure drop can be expressed as

$$\Delta P = q(t)\, P_c(t) \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where $q(t)$ refers to the stabilized constant rate condition, and $P_c(t)$ is expressed by Eq. VIII-11 of the Laplace Transformation[1]. Where the skin effect is included, however, this equation is expressed as,

$$P_c(t) = \int_0^\infty \frac{(1-e^{-u^2 t})\ du}{u\left\{\left[1-u^2\bar{C}S+u^2\bar{C}\frac{\pi}{2}Y_o(u)\right]^2+\left[u^2\,\bar{C}\frac{\pi}{2}J_o(u)\right]^2\right\}} \quad . \quad . \quad (5)$$

where $J_o(u)$ and $Y_o(u)$ are Bessel Functions of the first and second kind, respectively, and of zero order. The constant $\bar{C}$ is the unloading, and is given as $\bar{C} = C/2\pi f c R_b^2$, with C the volume of fluid unloaded from the annulus, expressed as cubic centimeters per atmosphere bottom-hole pressure drop. Further when S is zero the reader will observe that Eq. (5) is identical with Eq. VIII-11 for a uniform sand.

There is no attempt here to show work curves for this formulation, but the analytics reveal that when the unloading becomes stabilized in a sufficient length of time to allow the entry of fluids into the well bore to become constant, then

$$P_c(t) = [S + P(t)]$$

and we have the constant rate problem with the skin effect expressed in Eq. 1.

Although the discussion for the variable rate case in the initial stage of pressure draw-down has been referred to as fluid unloading from the annulus, this does not imply that this condition exists in all wells. Rather it is recognized that the problem can be much more complicated, which consists of the unloading, but also in overcoming the inertia in filling up the tubing for fluids partially standing in the flow string. The basis for this interpretation has been an empirical prognostication of the production data measured in the stock tank to relate the rate of fluid entry into the well bore from the reservoir proper.

In this connection, it has been observed that when fluid is standing in the tubing, that it takes from a few minutes to one-half hour for the oil to "hit" the separator, and then the stock tank. In effect what is recorded at the stock tank is a straight line relationship in plotting the cumulative production data versus time from opening the wing valve as shown in Fig. 2, and indicated by the full line. Although it is recognized that the slope of this line, $q(T)$, when corrected to reservoir conditions, corresponds to the constant rate case when the bottom-hole pressure levels off, Curve "B," Fig. 1, yet the data as plotted reveals a gap for the variation of the cumulative production, or its corresponding rate, which exists at early times for fluid entry into the well bore. Nevertheless, the physical nature of the problem is such that at zero time both the production and rate must be equal to zero. Further, for large times, the cumulative production should coincide with the straight line shown in Fig. 2, or

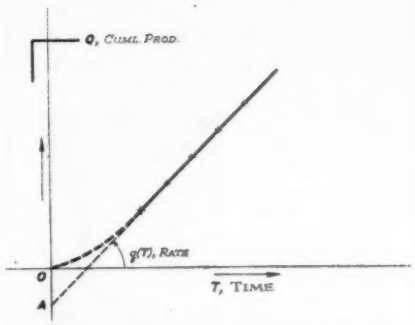


FIG. 2. Empirical determination of rate of fluid entry into well bore.

$$Q = -A + q(T)T \quad . \quad . \quad . \quad . \quad (6)$$

However, if we superimposes in this formula an empirical term $A_e^{-q(T)T/A}$ to satisfy the conditions of the problem, then

$$Q = -A + Ae^{-q(T)T/A} + q(T)T \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

which shows that for $T = o$, $Q = o$, and for T large Eq. 6 is defined. Likewise, by differentiation with respect to time,

$$\text{Rate} = q(T)\ [1 - e^{-q(T)T/A}] \quad . \quad (8)$$

which gives zero rate for $T = o$, and the stabilized rate $q(T)$ when time is large. Essentially what has been reproduced is an empirical curve passing through the origin in conformance with the production rate that exists in the well bore in early times. In its application to bottom-hole pressure drawn-down curve to simulate the variable rate problems, Eq. (8) is defined as

$$\text{Rate} = q(T)\ [1 - e^{-\alpha t}] \quad . \quad . \quad (8)$$

Where,

$$\alpha = \frac{q(T)\ f\ \mu\ c\ R_b^2}{AK}$$

as it is applied in the mathematical analysis.

Comparable to the variable rate case for the unloading problem, the cumulative pressure drop for the empirical method can be expressed as

$$\Delta P = q(t)\,[S + P_\alpha(t)] \quad . \quad . \quad (9)$$

where the skin effect is treated as a separate identity as its part of the contribution for pressure drop that occurs between static and flowing bottom-hole pressure. However, at all times, although $P_\alpha(t)$ is joined with the stabilized rate $q(t)$, the S term must be explicitly accounted for with the variable rate expressed by Eq. (8), whereas at time of stability the constant rate becomes effective as indicated in Eq. (9).

The formula for $P_\alpha(t)$ is expressed by the transcendental functions to be

$$P_\alpha(t) = P(t) - \frac{e^{-\alpha t}}{2}\,[-\log \alpha - 2\gamma + \log 4 + \text{Ei}(\alpha t)] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

with γ Euler's constant, equal to 0.57722, and

$$\text{Ei}(\alpha t) = \int_{-\alpha}^{\alpha t} \frac{e^u}{u}\ du$$

for which complete tables can be found in the texts, "Tables of Sine, Cosine, and Exponent Integrals," Volumes 1 and 2,

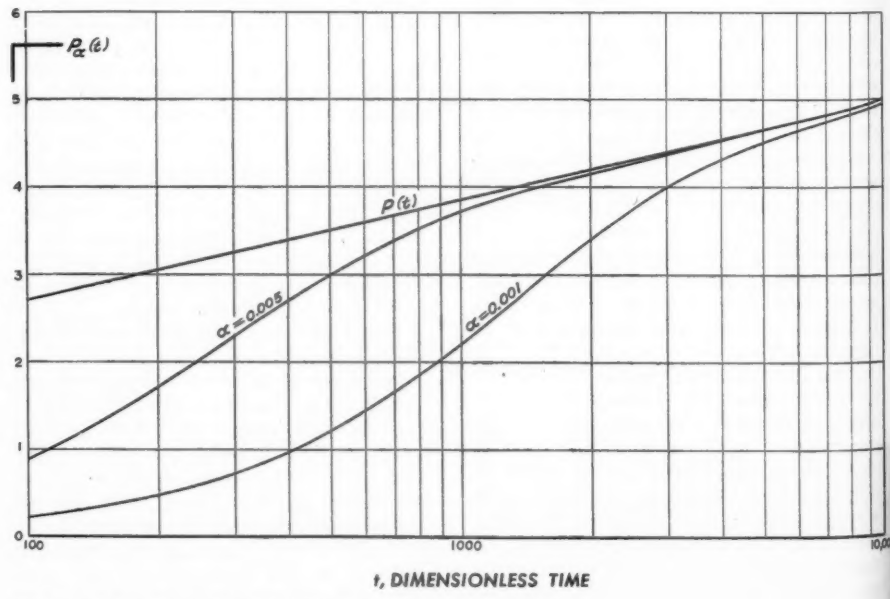
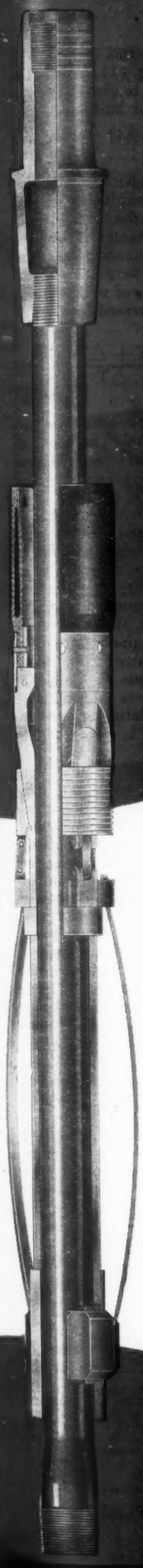


FIG. 3. Unloading established for the empirical method.



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Federal Works Agency. The variation of $P_\alpha(t)$ versus α and t is illustrated in the graph shown in Fig. 3.

The pertinent observations to note from Eq. (10) and Fig. 3, are that when time is large and stability of flow occurs, $P_\alpha(t) = P(t)$, which applied to Eq. (9), yields the identical formula as the previous example, namely the constant rate case, which incorporates the skin effect expressed by Eq. 1. In brief, both the unloading and the empirical method yield the same results for a stabilized well, and for the purpose of this paper either method can be employed in the superposition theorem to reproduce the flow characteristics at large times.

Superposition Application

It has been shown in the Laplace Transformation[1], that the cumulative pressure drop for a bottom-hole pressure decline curve, can be represented as a series of constant rate plateaus as illustrated in Fig. 1-B in that publication, taking cognizance of the change in rate from the time of its inception, and accumulating each increment in rate as a separate and distinct constant rate problem to yield the total pressure drop incurred in the well bore at a specified time. This is expressed as

$$\Delta P = q(o)\, P(t) + [q(t_1) - q(o)]\, P(t - t_1) + [q(t_2) - q(t_1)]\, P(t - t_2) + \ldots \quad (11)$$

where t_n is the instant of inception of rate $q(t_n)$, and $t - t_n$ refers to the period of time that its increment over the previous rate prevails to final time.

To simplify presentation of the variable rate problem in the superposition theorem, it will be assumed that the constant rate steps are in effect as indicated in Eq. (11), but with only two essential rate changes taking place: One is in opening the well to production at zero time, causing the bottom-hole pressure to decline, Fig. 1, and, secondly, shutting-in the well at time t, retarding the rate of production and permitting the bottom-hole pressure to build-up Curve "C," Fig. 1. The time of shut-in, following the period of flow is designated as $\triangle t$, and the cumulative pressure drop that is defined on the build-up curve is for time $t + \triangle t$. Thus the total pressure drop between static and build-up pressure is expressed, in accordance to the sequence of Eq. 11, as

$$\begin{aligned}\Delta P &= \\ &q(o)P(t+\triangle t)+[q(t)-q(o)]P(\triangle t) \\ &= q(o)P(t+\triangle t) - [q(o)-q(t)] \\ &\qquad P(\triangle t) \quad \ldots (12)\end{aligned}$$

Although it has been assumed for the purpose of simplicity in notation, that these are constant rate steps, actually we are dealing with the variable rate problem, which can be expressed either by the fluids unloaded from the annulus or the empirical method. In this presentation the former will be employed.

Thus, the first term to the right of Eq. 12 is the draw-down curve in Fig. 1, continued as an extension to time of buildup, namely $t+\triangle t$, which is expressed as

$$q(o)P_e(t+\triangle t)$$

where $q(o)$ is the stabilized constant rate i.e., the term $q(o)$ is $q(t)$ in Eq. (4), but is only employed in this instance to conform with Eq. (12). The interchange in legend will be made later. Further, when the time of flow t is large, which is observed in field performance, this term equals

$$q(o)[S+P(t+\triangle t)]$$

The value $q(t)$ in Eq. (12) represents the decline in rate of production upon closing in the well. Although it is often considered that when a well is shut-in its rate of production immediately goes to zero, this is not the case. Actually, what happens is that the fluid has entry into the well bore to load up the annulus, which is the reverse of the unloading. This loading, however, is a degenerating rate of fluid influx into the well bore, starting at the stabilized constant rate, and going to zero when $\triangle t$ becomes sufficiently large. The manner in which the stabilized rate and this degenerating rate appear as a difference in the bracket in the second term on the right hand of Eq. (12), is in effect an unloading, comparable to the unloading that occurs in a well when it is first opened to production at zero time. As this unloading will likewise yield the stabilized rate when $\triangle t$ is large, this second term is also expressed as

$$q(o)P_e(\triangle t)$$

Further, as a negative sign precedes this term, Eq. (12), specifically identifies this unloading as a superimposed effect on Curve "B," Fig. 1, to give the overall smaller cumulaitve pressure drop that occurs between static and build-up on Curve "C." In this respect, this second term is the difference between build-up and the final flowing pressure, and will have a predominant role in the presentation of the subject matter, as it can be treated independently to define the history of the build-up curve.

Therefore, the cumulative pressure drop to express the build-up curve is given by

$$\Delta P = q(o)\ [P_e(t+\triangle t) - P_e(\triangle t)]$$

or if one refers to the stabilized constant rate employed in Eq. 4, then

$$\Delta P = q(t)\ [P_e(t+\triangle t) - P_e(\triangle t)] \quad \ldots (13)$$

One of the more interesting aspects of Eq. (13) is its adaptability to determine the bottom-hole static pressure from a build-up curve. This problem often arises in pressure survey tests conducted in the field, particularly where the bottom-hole pressure is slow in build-up, and to establish final static pressure would entail testing the well beyond a time that would be economically feasible.

It has been stated that when stability of a flowing well is reached, or the comparable set of conditions, when the variable rate of influx for shut-in has largely disappeared, both terms in Eq. (13) can be expressed by Eq. (1), namely the constant rate problem, to give the cumulative pressure drop for build-up.

$$\Delta P = q(t)\ [P(t+\triangle t) - P(\triangle t)] \quad \ldots (14)$$

In this respect it will be observed that the skin effect term explicitly cancels out, which explains the difficulty of identifying this phenomenon in the past. Further, when dimensionless time $t \geqslant 100$, which occurs very early in the flow and shut-in periods of well performance, $P(t)$ can be expressed by Eq. (2) to give

$$\Delta P = \frac{q^{(T)}\,\mu}{4\pi KH} \log \frac{T+\Delta T}{\Delta T} \quad \ldots (15)$$

where again the logarithmic term implies natural logarithm. The time of build-up $\triangle T$ is associated with dimensionless $\triangle t$ by the expression $\triangle t = K\triangle T/f\mu c R_b^2$.

A perusal of Fig. 1 will show that as the time of flow t is fixed, but the time of build-up $\triangle t$ can increase indefinitely, means that the term within the logarithm can approach unity as a limit, to give a cumulative pressure drop equal to zero, or the equivalent of static conditions. Essentially this amounts to plotting the actual pressure of build-up on a linear scale versus the value of $\triangle T/(T+\triangle T)$ on a logarithmic scale§, and the extrapolation of pressure to $\triangle T/(T+\triangle T) = 1$, gives the static formation pressure.

Although this is the theoretical consideration, if it is not employed judicially with reservoir performance it can be extremely misleading. For one thing, the period of flow prior to shut-in must be known, which in many instances few records are kept. But the more important aspect, the extrapolation of pressure to the value of unity on the logarithmic scale, may involve a time range into the future that far in extent exceeds the present stage of depletion in the field. This is one of the factors that must be guarded against, and this phase of the subject will again be touched upon in the determination of the skin effect, which leads us to the next section.

When the flow period is significant, and added to it is the small increment for time of build-up, it will in effect cause little or no change in the $P(t+\triangle t)$ term expressed in Eq. (14). Therefore, in the interpretation of the superposition theorem, and the significant influence that the skin effect exerts in maintaining the flowing bottom-hole pressure constant, the second term in Eq. (13) gives the difference in pressure between build-up and final flowing bottom-hole pressure, or

$$\Delta P_B = q(t)\ P_e(\triangle t) \quad \ldots (16)$$

which is independent of the time of flow. Again, for the unloading or the

§The manner of plotting the argument within the logarithmic expression of Eq. (15) is purely arbitrary. Although the mathematical context of this equation refers to $(T+\Delta T)/\Delta T$ as the value for the abscissae, it is interchanged to give $\Delta T/(T+\Delta T)$ for convenience in plotting an increasing function of time with increasing bottom-hole pressure.

XUM

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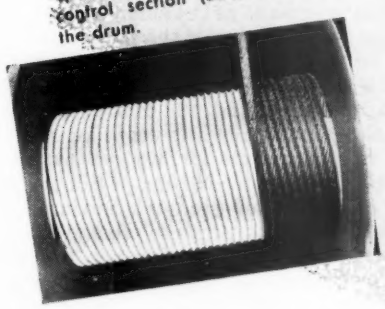

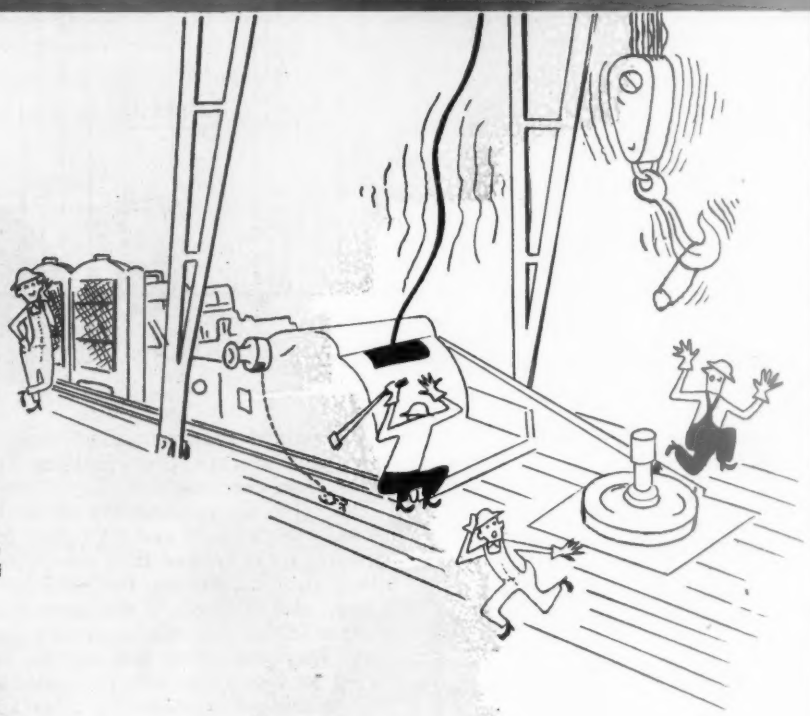

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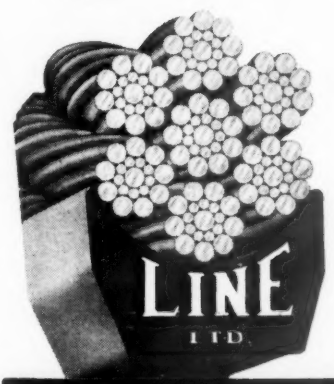

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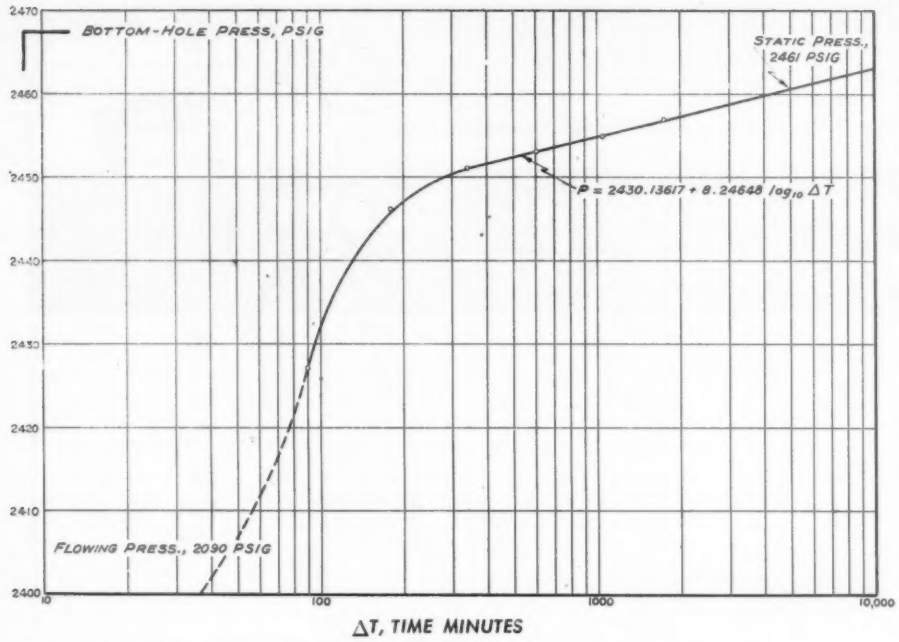

FIG. 4. Bottom-hole pressure build-up curve, oil well.

empirical method, if the variable rate effects in build-up have largely disappeared, Eq. (16) can be expressed comparable to Eq. (1), to give

$$\triangle P_B = q(t)[S + P(\triangle t)]$$

If one introduces Eq. (2) and ascribes all terms relating to the constant flow $q(t)$, then

$$\triangle P_B = \frac{q(T)\mu}{4\pi KH}\left[2S + 0.80907 + \log\frac{K}{f\mu c R_b^2} + \log\triangle T\right] \quad . \quad . \quad . \quad (17)$$

It has been observed from many build-up tests that a plot of bottom-hole build-up pressure versus the logarithm of time $\triangle T$, gives a straight line relationship for increased times, as defined in Eq. (17). Furthermore, the slope of this line determines the productive capacity of the formation proper KH, as given in the coefficient constant $q(t)\mu/4\pi KH$.

Although the actual plotting of the build-up pressure versus time on a semi-log graph, Fig. 4, shows an inflection type curve to indicate a straight line, the extrapolation of this straight line to early times, such as $\triangle T = 1$ second on the graph, taking account of the slope, yields the constant in this formula containing the skin effect namely

$$\text{Constant} = 2S + 0.80907 + \log\frac{K}{f\mu c R_b^2} \quad . \quad . \quad . \quad (18)$$

The factor that appears in Eq. (17), aside from the constant rate, which can be readily established from field data, is the net effective sand thickness H, determined from an electric log. This applied to formation capacity KH, as established from the slope, gives the permeability of the formation in situ. In this connection, it may be of interest to the reader to know that permeabilities so determined show a marked consistency with average permeabilities obtained from core analysis.

The value for permeability so established, with the core and PVT data for porosity, viscosity, and fluid compressibility, and introducing the well bore radius, give $K/f\mu cR_b^2$, the term that appears in the skin effect constant, Eq. (18). Whatever errors that may be incurred in this value will be considerably minimized because this term appears as a logarithm, which has little change for an appreciable change in $K/f\mu cR_b^2$. In brief, what can be established from Eq. (18) is the order of magnitude of the skin effect, namely S, from bottom-hole pressure build-up data.

Finally, Eq. (17) is applicable for the establishment of static formation pressure, independently of the time of flow. In this connection the author accepts the realism of the limitations with which bottom-hole pressure can be measured in the field, rather than an extrapolation to large times. If the limit of bottom-hole pressure instrumentation is one pound per square inch per day, or some other value established in a given area, then differentiation of Eq. (17) with $\triangle T$, gives

$$\frac{d\triangle P_B}{d\triangle t} = \frac{q(T)\mu}{4\pi KH\triangle T} \quad . \quad . \quad . \quad . \quad (19)$$

Thus, the introduction of the proper units in Eq. (19), and taking account of this rate of pressure change, fixes the time of build-up. This value in turn, read on the straight-line for the semi-logarithmic graph, gives for all practical purposes the static formation pressure.

Engineering Applications

The engineering application of the work hereto presented to establish the skin effect from bottom-hole pressure draw-down and build-up curves, are illustrated in this section for an oil well and a gas well. At the outset it can be mentioned, that even though the cases considered here reveal the significant influence of the skin effect in impeding the flow of fluids into the well bore, it is to be emphasized that these are comparable sets of conditions encountered in a large number of wells studied to date. In brief, the skin effect is a common occurrence, which accounts in many instances for a large per cent of the overall pressure drop between static and flowing bottom-hole pressure, as will be shown in the illustrated examples.

The first case considered is the establishment of the skin effect for an oil well that has been on production, followed by a period of shut-in, for which bottom-hole pressure build-up data have been recorded. This well is producing from the Tensleep Formation in the Rocky Mountain area, as an open hole completion in an undersaturated reservoir. The bottom-hole pressure build-up data are plotted on the semi-logarithmic graph shown in Fig. 4. The basic data, as well as the engineering calculations to establish this skin effect are given in Table 1.

This table is self explanatory, with the necessary calculations to facilitate its understanding for the reader. Thus, the straight line portion of build-up, shown in Fig. 4, is computed by the method of least squares to indicate a static formation pressure of 2461 psig for 1 psi per day pressure change. By means of the slope for this line, the permeability of the formation is established as 331 md in situ. The skin effect, or the impediment to fluid flow, is specifically identified, and as the reader will observe the pressure drop for the skin effect accounts for 309 psi, out of an overall pressure change of 371 psi, or 83.3 per cent of the total, leaving 17.7 per cent of the pressure change taking place in the formation proper, which shows that the impediment is significant.

Finally, as has previously been mentioned, when the skin effect is appreciable, the productivity index to a large degree reflects the skin effect. This is well illustrated in the present example, which gives a productivity index of 2.44 bbl per day per pound per square inch, computed from the build-up curve and the skin effect, whereas the actual productivity index for the flow condition is 2.02 bbl per day per pound per square inch pressure drop. A reference to Eq. (3) shows that if the skin effect could be reduced the productivity index would be significantly increased. This essentially is a challenge to the industry, and is one of the reasons for the presentation of this paper.

The engineering computations so employed are consistent with the analytics presented in the text, with only one departure, namely the application of dimensionless time, $t = KT/f\mu cR_b^2$. In this connection the effect of connate water has been introduced, which yields for dimensionless time $t = KT/f(1\text{-}C_w)\mu cR_b^2$. The corresponding dimensionless time that applies to a gas well, provided that the difference between static and

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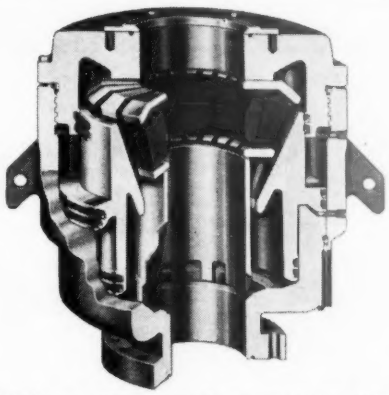

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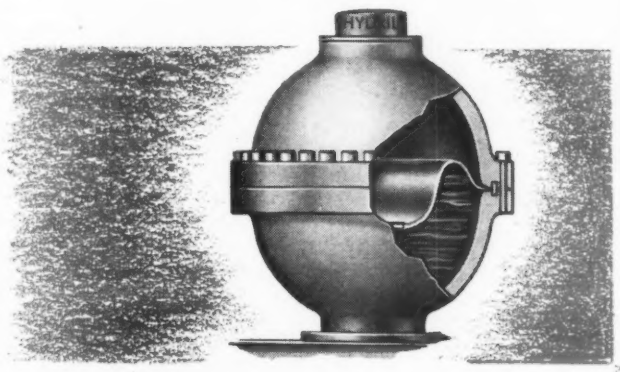

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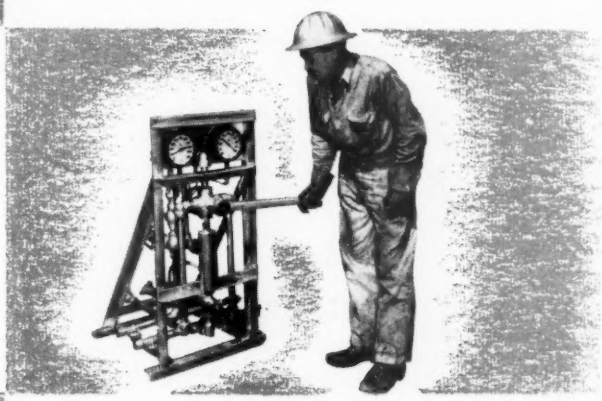

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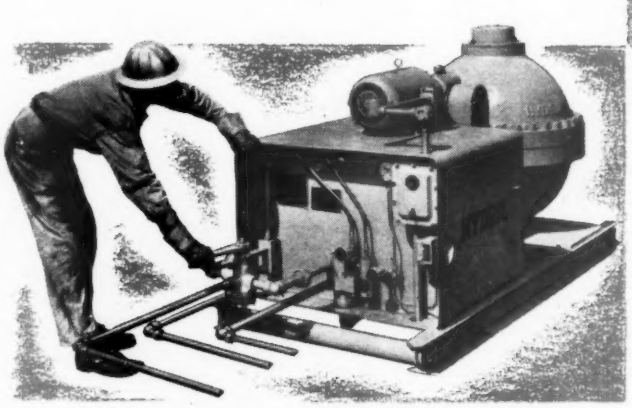

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TABLE 1. Establishment of the skin effect for an oil well. Rocky Mountain area.

Basic Data

Rate of production, 749 bbl/day

Final flowing bottom-hole pressure, 2090 psig
Formation volume factor, 1.07
Net effective sand thickness, 245 ft
Porosity, 13%
Connate water, 10%
Viscosity reservoir crude, 5.13 Centipoises
Compressibility reservoir crude, 1.013 $(10)^{-4}$ Vol/Vol/Atms
Well bore, 9" diameter

Build-up Data

Time Shut-in minutes	Bottom-hole pressure psig, @ -1125 ft	
0	2090	
90	2427	
180	2446	
346	2451)	Determination straight-line
606	2453)	Semi-logarithmic graph, Fig. 4
1038	2455)	Method of least squares:
1726	2457)	$P=2430.13617+8.24648 \log_{10}\Delta T$.

Determination Static Formation Pressure

Limitation bottom-hole pressure instrumentation, build-up 1 psi/day

As,

$$P = 2430.13617 + 8.24648 \log_{10}\Delta T$$

Where,

$\log_e 10 = 2.30259$, or $\log_e A = 2.30359 \log_{10} A$

1 day = 1440 minutes

$$\frac{dP}{d\Delta T} = \frac{8.24648}{2.30259\Delta T} = \frac{1}{1440}, \text{ Eq. (19)}$$

$\Delta T = 5157$ minutes

$P = 2461$ psig, Fig. 4

Productive Capacity of Formation

Slope of straight-line, Fig. 4

Where,

1 atms = 14.7 psi

$$\frac{q(T)\mu}{4\pi KH} = \frac{8.24648}{(2.30259)(14.7)} \text{ Eq. (17)}$$

$= 0.24363$

As,

$q(T) = (749)(1.07)(1.840) = 1474.6$ cc/sec., Res. Cond.

1 bbl/day = 1.840 cc/sec.

$\mu = 5.13$ Cp.

$H = (245)(30.48) = 7467.6$ cm

1 ft = 30.48 cm

Therefore,

$$\frac{(1474.6)(5.13)}{4\pi KH} = .24363$$

$KH = 2{,}470.9$ Darcy—cm

$K = 0.33090$ Darcys $K = 331$ Md

Determination of the Skin Effect

Pressure @ 1 sec.

$P = 2430.13617 - 8.24648 \log_{10} 60 = 2415.47269$ psig

Where,

1 min = 60 sec.

Extrapolated build-up pressure, 1 sec.

$\Delta PB = 2415.47269 - 2090 = 325.47269$ psi, or 22.14100 a ms

Flowing bottom-hole pressure @ shut-in, 2090 psig

Therefore,

$$(\Delta PB) \div (q(T)\mu/4\pi KH) = \frac{22.14100}{.24363} = 90.87961$$

Then,

$$90.87961 = 2S + 0.80907 + \log \frac{K}{f(1\text{-}Cw)\mu c\, Rb^2}, \text{ Eq. (18)}$$

As,

$$\frac{K}{f(1\text{-}Cw)\mu c Rb^2} = \frac{0.331}{(13)(.90)(5.13)(1.013)(10)^{-4}(11.43)^2} = 41.66988$$

$Rb = \frac{(9)}{2}(2.54) = 11.43$ cm

$S = 43.16990$ Dimensionless

Pressure Drop Due To Skin Effect

$$P = \frac{q(T)\mu S}{2\pi KH} = (2)(.24363)(43.16990)(14.7)$$

1 atms = 14.7 ps

$= 309.2$ psi

Overall pressure drop between static and flowing pressure

2461-2090 = 371 psi

Per cent pressure drop due to skin effect

$$\frac{309.2}{371} \times 100 \quad 83.3\%$$

Productivity Index

Flowing well

$$\frac{749}{371} = 2.02 \text{ bbl per day per psi, cuml press drop}$$

Productivity index calc. from skin effect and build-up

$$\frac{q(T)}{\Delta P} = \frac{2\pi KH}{\mu S}, \text{ Eq. (3)}$$

$$= \frac{(2\pi)(2470.9)}{(5.13)(43.16990)} = 70.5 \text{ cc/sec./atm.}$$

$$= \frac{70.5}{(1.840)(1.07)(14.7)} = 2.44 \text{ bbl per day psi}$$

flowing pressure is not excessive with respect to the former, is $t=KP_oT/f(1\text{-}C_w)\mu R_b^2$, where the static formation pressure is the reciprocal of compressibility.

The second case presented is a build-up test on a gas well in the Gulf Coast area. The bottom-hole pressure data are plotted in Fig. 5, and the illustrative calculations are given in Table 2. This well, as in the previous case, shows a large skin effect to indicate that 78.5 per cent of the total pressure drop occurs at the impediment, with 21.5 per cent of the pressure drop in the formation itself. Therefore, it is evident that the skin effect in a gas well is of an appreciable order of magnitude as observed in an oil well.

Discussion

The problems presented definitely reveal that in the immediate vicinity of the well bore, an impediment exists that obstructs the flow of fluids into a well. To illustrate graphically this situation, Fig. 6 has been prepared to show the drop in pressure that occurs in the formation proper and across the skin effect for the two cases considered. The subject has large ramifications, and the solution suggests needed improvements in methods of well completions. In this respect the author will give a brief account of factual examples that have partially overcome this skin effect. The use of oil base muds as well as oil emulsion muds in California have shown an increase in productivity index from two to four fold over water base muds, where the comparison for productive capacities for the formation have been based on core analyses. The reworking of wells by reperforation and acid treating have contributed to reduce this skin effect. Finally, recent developed methods by service companies in fracturing the formation probably have contributed largely in penetrating this impediment, which explains the degree of success encountered.

Although considerable time and effort has been expended, it is not the conclusion of the author that all the engineering aspects of the problem have been solved completely. For one thing, the limitation in the employment of the final build-up pressures, as shown in Figs. 4 and 5, leaves much to be desired, and for this reason the skin effect has been referred to in this work only as an order of magnitude.

Therefore, before leaving the subject, the author presents another method for computing the skin effect that could lead to more accurate interpretations. In this respect, the total build-up curve, including the inflection portion in early times,

FIG. 5. Bottom-hole pressure build up curve, gas well.

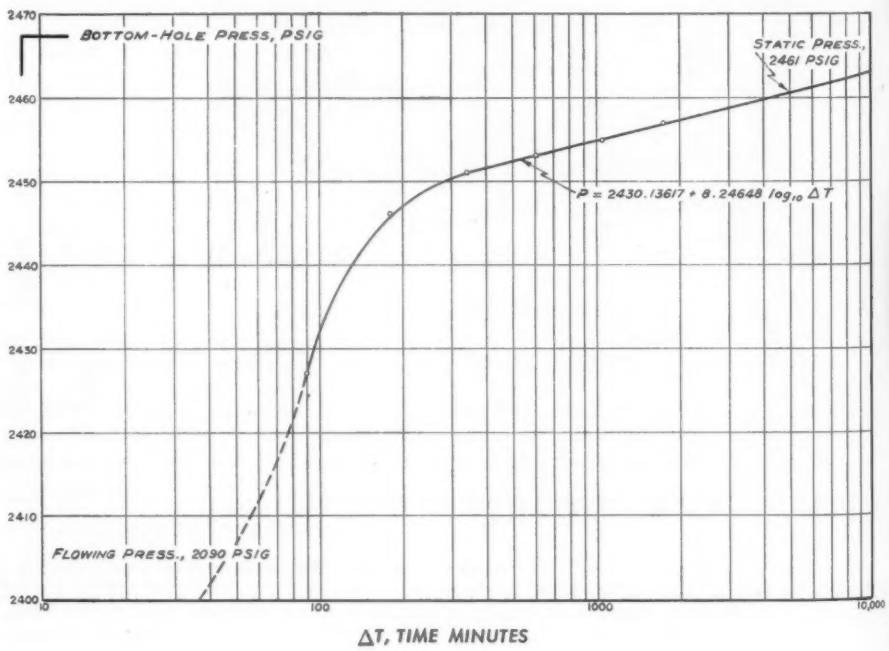

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TABLE 2. Establishment of the skin effect for a gas well. Gulf Coast area.

Basic Data

Rate of gas production, 5.304 MM cu ft/day @ S.C.
Final flowing bottom-hole pressure, 4166 psig
Net effective sand thickness, 81 ft
Porosity, 25%
Connate water, 25%
Viscosity gas, 0.02 Centipoises
Well bore, 6" diam.
Res. temp. 257 F

Build-up Data

Time shut-in, minutes	Bottom-hole pressure, psig	
0	4166	
2	4610	
4	4910	
6	5068	
8	5111)	Determination straight-line
10	5116)	Semi-logarithmic graph, Fig. 5
12	5120)	Method of least squares:
16	5129)	
20	5131)	$P = 5068.58894 + 47.88033 \log_{10}\Delta T$.
24	5135)	
28	5137)	
32	5140)	
36	5143)	
40	5143	
1390	5143	
2740	5143	

Determination Productivity Capacity of Formation

$$\frac{q(T)\mu}{4\pi KH} = \frac{47.88033}{(2.30259)(14.7)}, \text{ Eq. (17)}$$

$$= 1.41457$$

$$q(T) = (5.304)\frac{(14.7)}{(5158)}\frac{(717)}{(520)}(1.026) = .021385 \text{ MM cu ft/day @ res Cond}$$

$$= (21{,}385)(.178)(1.840) = 7{,}004 \text{ cc/sec. @ Res Cond}$$

Where,

1.026, gas compressibility
1 cu ft = 0.178 bbls
1 bbl/day = 1.840 cc/sec
1 ft = 30.48 cm

$\mu = 0.02$
$H = (81)(30.48) = 2{,}468.9$ cm

Therefore,

$KH = 7.880$ Darcy — cm
$K = 0.003192$ Darcy's; $K = 3.2$ md

Determination of the Skin Effect

Pressure @ 1 sec.,
$P = 5068.58894 - 47.88033 \log_{10}60 = 4983.45053$ psig
Extrapolated build-up pressure, 1 sec.
$\Delta PB = 4983.45053 - 4166 = 817.45053$ psi, or 55.60888 atms
Therefore,

$$(\Delta PB) \div (q(T)\mu/4\pi KH) = \frac{55.60888}{1.41457} = 39.31151$$

Then,

$$39.31151 = 2S + 0.80907 + \log \frac{}{f(1\text{-}Cw)\mu Rb^2}$$

As,

$$\frac{K\,Po}{f(1\text{-}Cw)\mu Rb^2} = \frac{(0.003192)(350.88435)}{(.25)(.75)(.02)(7.62)^2} = 5.14382$$

Where,
Flowing bottom-hole pressure @ shut-in, 4166 psig

$$Po = \frac{5158}{14.7} = 350.88435 \text{ atms}$$

$Rb = (.25')(30.48) = 7.62$ cm

$S = 18.43233$ dimensionless

Pressure Drop Due to Skin Effect

$$\Delta P = \frac{q(T)\mu}{2\pi KH} S = (2)(1.41457)(18.43233)(14.7) = 766.6 \text{ psi}$$

Overall pressure drop between static and flowing pressure
$5143 - 4166 = 977$ psi
Per cent pressure drop due to skin effect

$$\frac{766.6}{977} \times 100 = 78.5\%$$

Figs. 4 and 5 is considered. Thus, it can be observed a close analogy exists between the shape of the curves shown for empirical unloading, Fig. 3, and those given in the factual examples for build-up. Therefore, in the employment of the empirical method, which is recognized to fulfill more realistically the conditions of the problem, Eq. (9) can be expressed for the entire curve to give

$$\Delta P_B = q(t)\,(1 - e^{-\alpha \Delta t})\,S + P_\alpha\,(\Delta t)$$

and by Eqs. (2) and (10)

$$\Delta P_B = \frac{q(t)}{2}\left\{\left[2S + 0.80907 + \log \Delta t\right] - e^{-\alpha \Delta t}\left[2S - \log \alpha - 2\gamma + \log 4 + E_i(\alpha \Delta t)\right]\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

The differentiation of this expression with respect to time, to obtain the rate of pressure change is the relation

$$\frac{d\Delta P_B}{d\Delta T} \sim e^{-\alpha \Delta t}\left[2S - \log \alpha - 2\gamma + \log 4 + E_i(\alpha \Delta t)\right] \quad . \quad . \quad . \quad . \quad . \quad (21)$$

In brief, if bottom-hole pressure instrumentation were sufficiently precise to measure instantaneous pressure, Eqs. (20) and (21) would be apropos to establish the skin effect and the other factors from the entire build-up curve. Unfortunately, no instrument can record instantaneous readings for rapid pressure changes, as it usually takes five minutes for a pressure to stabilize in a recording gage. With reference to the bottom-hole pressure bomb, however, it may be possible to determine a correlation to establish the instantaneous pressure that would permit using this analysis for computing the skin effect.

To conclude, the basic concepts upon which this paper is developed involve the treatment of contour intergration of the Laplace Transformation, a branch of higher mathematics that cannot be included in a publication of this scope. For this reason, only the final formulations of the cases considered have been included in the text, and the individual mathematical solutions will be presented in the immediate future in a scientific journal devoted to mathematical analyses.*

*It is hoped that when such publication is forthcoming, this announcement will be made in *The Petroleum Engineer*.

Acknowledgement

The author wishes to acknowledge his appreciation to The British-American Oil Production Company for being permitted to employ some of the factual examples given in this paper.

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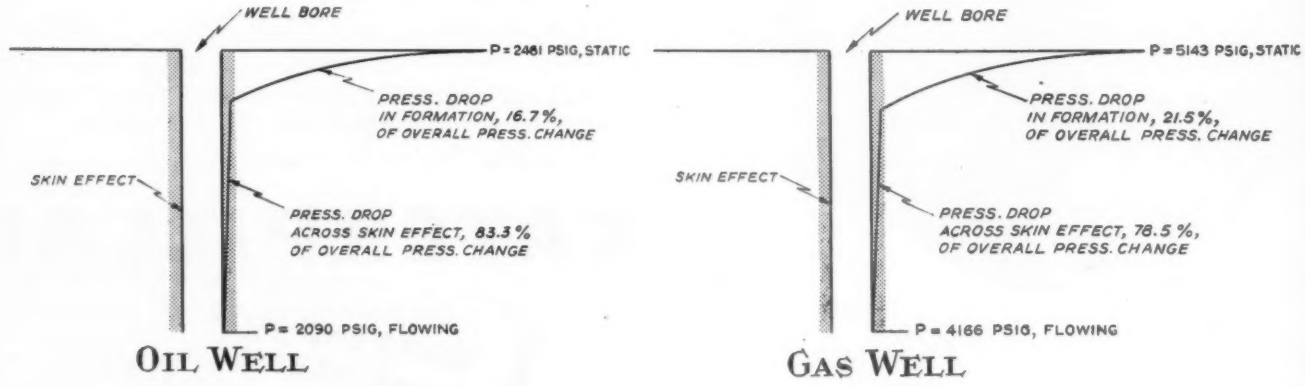
FIG. 6. Graphical description of pressure drop across the skin effect and sand proper.


WELL BORE
P = 2481 PSIG, STATIC
PRESS. DROP IN FORMATION, 16.7%, OF OVERALL PRESS. CHANGE
SKIN EFFECT
PRESS. DROP ACROSS SKIN EFFECT, 83.3% OF OVERALL PRESS. CHANGE
P = 2090 PSIG, FLOWING
OIL WELL
WELL BORE
P = 5143 PSIG, STATIC
PRESS. DROP IN FORMATION, 21.5%, OF OVERALL PRESS. CHANGE
SKIN EFFECT
PRESS. DROP ACROSS SKIN EFFECT, 78.5%, OF OVERALL PRESS. CHANGE
P = 4166 PSIG, FLOWING
GAS WELL

EXCLUSIVE

Deep Well Mud Program for West Texas

Excellent hole performance and absence of gellation problems recorded in Val Verde County deep wildcat test

C. D. ALLEN, JR.

A CLOSELY controlled mud program has been found necessary for successful deep drilling operations in the Val Verde area of West Texas. Operations in the subject well were complicated by the 13,000 ft Pennsylvanian shale section that was successfully drilled with a high gel strength mud, a high pressure zone at 10,000 ft requiring more mud weight than was desirable for drilling the upper shale and temperatures in excess of 250 F encountered below 14,260 ft.

Phillips Petroleum Company's B. E. Wilson No. 1 provides a good example of a solution to these drilling problems. This well, situated in northern Val Verde County 52 miles southwest of Sonora, was spudded June 9, 1951 and drilled to a total depth of 16,456 ft with remarkably little hole trouble.

Mechanical Equipment and Drill Pipe Used

Major equipment items of the Delta-Gulf Drilling Company's Rig No. 8 were a National 100 drawworks, one National C-350 circulating pump, one National C-250 mud mixing and standby pump, and three Superior G-510 engines. Surface mud volume storage capacity consisted of one 250 bbl and two 185 bbl steel tanks. Eighteen 6¼-in. drill collars with 4½-in. drill pipe were used to 12,752 ft. From this depth to total depth, 3½-in. drill pipe was used with twelve 4¾-in. drill collars.

Casing and Bit Record

Casing program consisted of 13⅜-in. casing set at 480 ft and 9⅝-in. casing set at 1550 ft. While drilling 8¾-in. hole at 13,517 ft, the top three joints of the 9⅝-in. casing were damaged. After cement squeezing attempts to repair the split casing failed, it became necessary to set 7⅝-in. casing at 2574 ft. Hole size below the 7⅝-in. casing was 6¾-in. to 14,979 ft. From 14,979 to total depth, 6⅝-in. hole was drilled.

A total of 316 rock bits were used to 14,979 ft. Twenty-two core heads, three 6½-in. clean-up bits, and three diamond bits were used from 14,979 ft to total depth of 16,456.

Drilling Mud Record

Long black shale sections of Pennsylvanian Age extended from 695 to 13,845 ft. Aquagel and light soda ash treatments were employed immediately below the 9⅝ in. casing to provide a low pH, 35-40 second viscosity mud. Mud density was maintained below 10 lb per gal. Gel strengths and filter loss were normal for this type of fresh water mud. No particular treatment was necessary to control filter loss below 14 cc, API. Average mud properties to 9200 ft were as shown in Table 1.

TABLE 1.

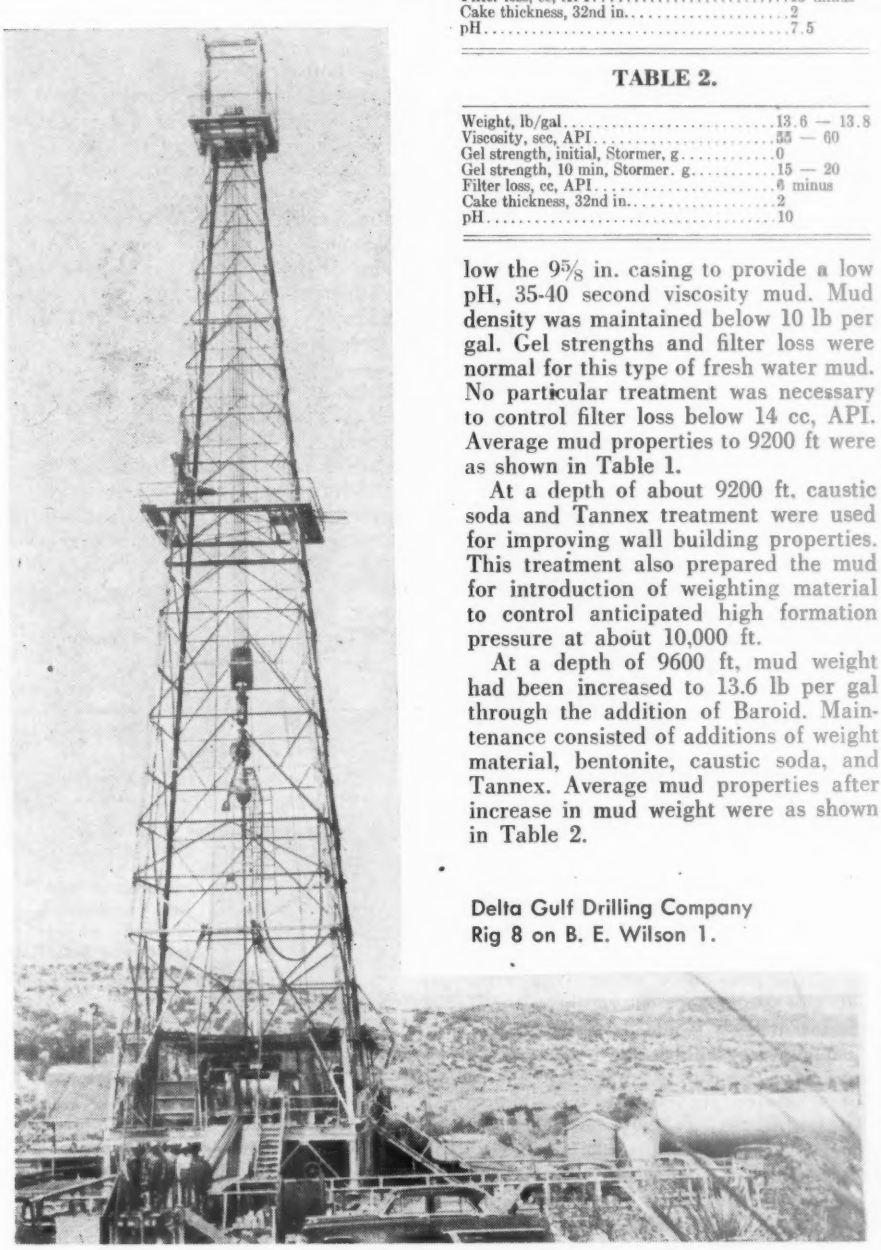
Weight, lb/gal	9.7 — 9.8
Viscosity, sec, API	45 — 50
Gel strength, initial, Stormer, g	0 — 2
Gel strength, 10 min, Stormer, g	35 — 40
Filter loss, cc, API	15 minus
Cake thickness, 32nd in.	2
pH	7.5

TABLE 2.

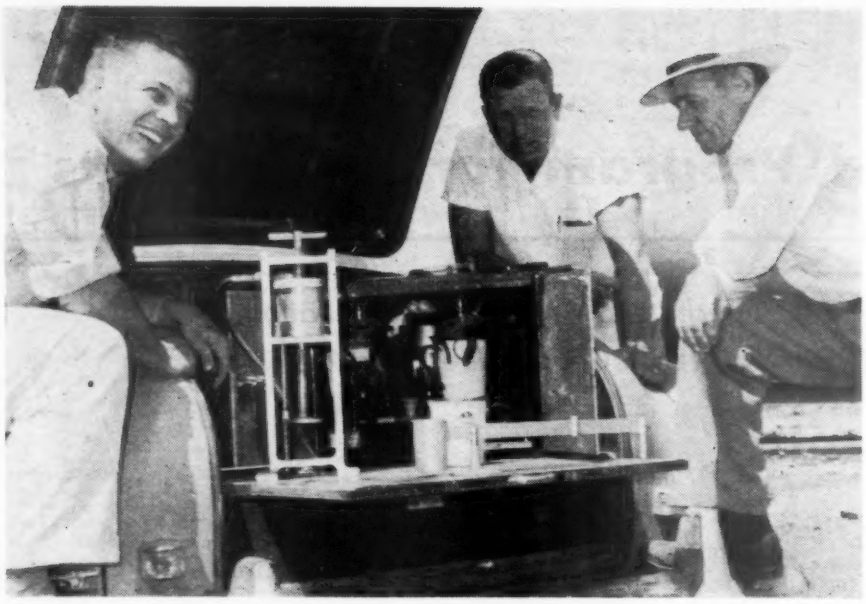
Weight, lb/gal	13.6 — 13.8
Viscosity, sec, API	55 — 60
Gel strength, initial, Stormer, g	0
Gel strength, 10 min, Stormer. g	15 — 20
Filter loss, cc, API	6 minus
Cake thickness, 32nd in.	2
pH	10

At a depth of about 9200 ft, caustic soda and Tannex treatment were used for improving wall building properties. This treatment also prepared the mud for introduction of weighting material to control anticipated high formation pressure at about 10,000 ft.

At a depth of 9600 ft, mud weight had been increased to 13.6 lb per gal through the addition of Baroid. Maintenance consisted of additions of weight material, bentonite, caustic soda, and Tannex. Average mud properties after increase in mud weight were as shown in Table 2.



Delta Gulf Drilling Company
Rig 8 on B. E. Wilson 1.



C. D. Allen, Baroid engineer; M. T. Johnson, tool pusher for Phillips Petroleum Company, and Lewis White, tool pusher for Delta Gulf Drilling Company are on location of B. E. Wilson 1.

Because the expected pressure zone in the lower Pennsylvanian was not encountered, the mud weight was allowed to decrease to below 11 lb per gal. This was accomplished through water dilution. Viscosity was increased with bentonite to 65 - 70 sec. At 11,775 ft, mud weight was increased to 11.5 lb per gal. Below 14,000 ft, unit mud weight specifications were 10.5 lb per gal or less for the balance of the drilling interval.

Mud treatment for correction of increasing gelation rate, due to the high bottom hole temperatures, was required at a depth of about 14,260 ft. The ratio of caustic soda to Tannex was decreased and water dilution was increased. This control of chemical ratios and water additions provided satisfactory mud properties to total depth. Mud characteristics at 15,415 ft where the bottom hole temperature was recorded as approximately 318 F were as shown in Table 3.

With the exception of the filter loss, the average mud properties to completion were as shown. Driscose was added below 15,821 ft for controlling filter loss within the 5 to 6 cc range.

Hole Performance

Hole conditions were considered excellent throughout the drilling of this well. There were 13,882 ft of open hole at total depth. Two hundred and nineteen days drilling time were required for drilling from 1550 to 13,517 ft. Then it became necessary to repair casing damage as previously noted. One hundred and eighty one more days were used for drilling from 13,517 to 16,456 ft. During this total of 400 drilling days more than 400 round trips were made without major rig repairs or serious hole trouble.

One of three fishing jobs occurred while making a trip at 7900 ft. A pin failure within 120 ft of the surface resulted in the lower drill collar falling to the bottom of the hole. Fishing required washing out bridges to 5000 ft and circulating to top of the fish. The fish was then picked up with an overshot and recovered on the first run.

A key seat developed at 2330 ft while drilling at 12,752 ft. The pipe stuck while coming out of the hole to pick up 3½-in. drill pipe. Oil was spotted and the fish freed after jarring for 54 hours. The key seat was then reamed and drilling resumed with 3½ in. drill pipe and 4¾ in. drill collars.

Although drilling progress was delayed for a continuous period of 22 days to repair the damaged 9⅝-in. casing, 11,967 ft of open hole remained free from bridges and bottom hole cavings. Trouble was never encountered while returning to bottom after shut down periods, (24 to 72 hours). This is unusual for such an extensive drilling project.

The core barrel became stuck on bottom at 16,344 ft. This was attributed to low circulating volume. Nine hours were required to circulate the mud through the hole with pump pressures of 1100-1200 psi. The drill pipe was shot-off at the top of the drill collars. The fish was then engaged and recovered after jarring for two hours. The 6½-in. bit was returned to bottom without difficulty. Increasing the fluid volume, together with a slight increase in viscosity and reduction in filter loss of the mud, permitted trouble free hole for continued drilling with 6⅝-in. diamond bit.

Well logging surveys, requiring 84 hours, were successfully completed at 15,262 ft without reconditioning the hole during that time. Three other well surveys and a velocity survey, the latter requiring 7 days, also were successfully completed without hole conditioning. Twelve drill stem testing tools were successfully run into the hole with the final test taken at 16,291 ft.

Maximum hole deviation was 2½ deg. Bottom hole temperatures ranged from 131 to 157 F while drilling the last 2000 ft of hole.

Table 4 shows representative mud characteristics while drilling the interval from 3312 to 16,449 ft.

The writer of this article assisted the operators in the mud control program used in drilling this relatively trouble free hole. The 171 trips to the well totaled approximately 40,700 driving miles.

* * *

☆ ☆ ☆

An oil well 5,000 ft deep was rare in 1925. Today, it is considered a relatively shallow hole because many modern wells are drilled down to 12,000 ft and more and three test wells have gone below 20,000 ft. With an expanding drilling program such as this, the oil industry can continue to find new oil reserves and provide amply for the nation's oil needs.

TABLE 3.

Weight, lb/gal	9.8
Viscosity, sec, API	81
Gel strength, initial, Stormer, g	0
Gel strength, 10 min, Stormer, g	0
Filter loss, cc, API	7.6
Cake thickness, 32nd in.	2
pH	9.0

TABLE 4.

Depth, feet	Viscosity sec. API	Weight lb/gal	Filter loss cc. API	Gel strength, g initial	Gel strength, g 10 min.	Cake inches	pH
3,312	42	9.6	13.8	..	..	2/32	7.0
4,483	47	9.8	13.2	..	..	2/32	7.5
6,633	45	10.0	12.4	2	51	2/32	7.5
7,243	48	10.1	12.0	..	..	2/32	7.5
8,993	55	10.2	10.8	..	..	2/32	8.0
9,763	64	13.8	4.8	0	27	2/32	10.0
10,750	67	12.3	4.6	..	..	2/32	10.0
11,643	90	10.2	6.4	0	33	2/32	10.0
12,168	57	11.7	4.8	1	30	2/32	10.0
13,101	72	11.6	5.2	0	38	2/32	10.0
13,705	71	11.4	5.6	0	41	2/32	9.5
14,570	83	10.8	5.8	0	23	2/32	9.5
15,091	83	10.7	4.4	0	1	2/32	9.5
15,466	81	9.9	7.8	0	0	2/32	9.0
15,821	86	9.6	6.0	0	2	2/32	9.0
16,140	86	9.7	6.4	0	4	2/32	9.0
16,291	78	9.9	5.6	0	3	2/32	9.0
16,449	83	10.2	5.6	0	3	2/32	9.0

The Author

C. D. Allen was graduated from SMU in 1945 with the degree of Bachelor of Science in geology and with a minor in chemistry and was immediately employed by the Baroid Sales Division of the National Lead Company in their well logging department. After wide experience in the Southwest, he was transferred to the mud division and stationed in San Angelo, Texas, as field engineer. He has served the San Angelo area in this capacity since 1948.

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DIESEL electric drilling barge of Sun Oil Company operates in Caplen area. Only one lost time accident has been experienced on this rig in over two years of continuous operation.

CREW has safety meeting. Supervisors are encouraged to call frequent brief meetings to plan and discuss unusual or hazardous operations.

In Drilling

SAFETY PROGRAM PAYS OFF

Fewer injuries, lower insurance rates, less equipment damage stem from employee training and leadership

J. THURMAN GREEN

GENERALLY speaking, the drilling of oil and gas wells is accepted as the most hazardous work done in the oil fields with the exception of rig building, and this is indicated by workmen's compensation rates. The only exceptions to high insurance costs are a few individual companies who have made a concerted effort to control personal injuries and eliminate causes of damaged equipment.

To get a true picture of the accident experience in the drilling industry, we should look at the industry as a whole for the background and need for controlling injuries to the operators' employees.

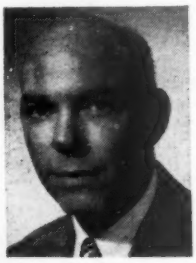
Before about 1930, tool pushers and drillers had the idea that there were just going to be a fixed number of injuries per thousand feet of hole drilled, and the roughnecks and drillers had to be rather rugged individuals even to desire employment on a drilling rig. Operators, individually, were paying various amounts for insurance depending on the size of their company and their experience.

During the early thirties, drilling rig owners and companies operating rigs began to take a second look at the exorbitant insurance premiums for workmen's compensation and began to make a sincere effort to control the personal injuries and at the same time prevent the economic loss they were suffering in damaged equipment.

Progress at first was rather slow, but as time went on tool pushers, drillers, and rig employees were convinced of the fact that better working practices

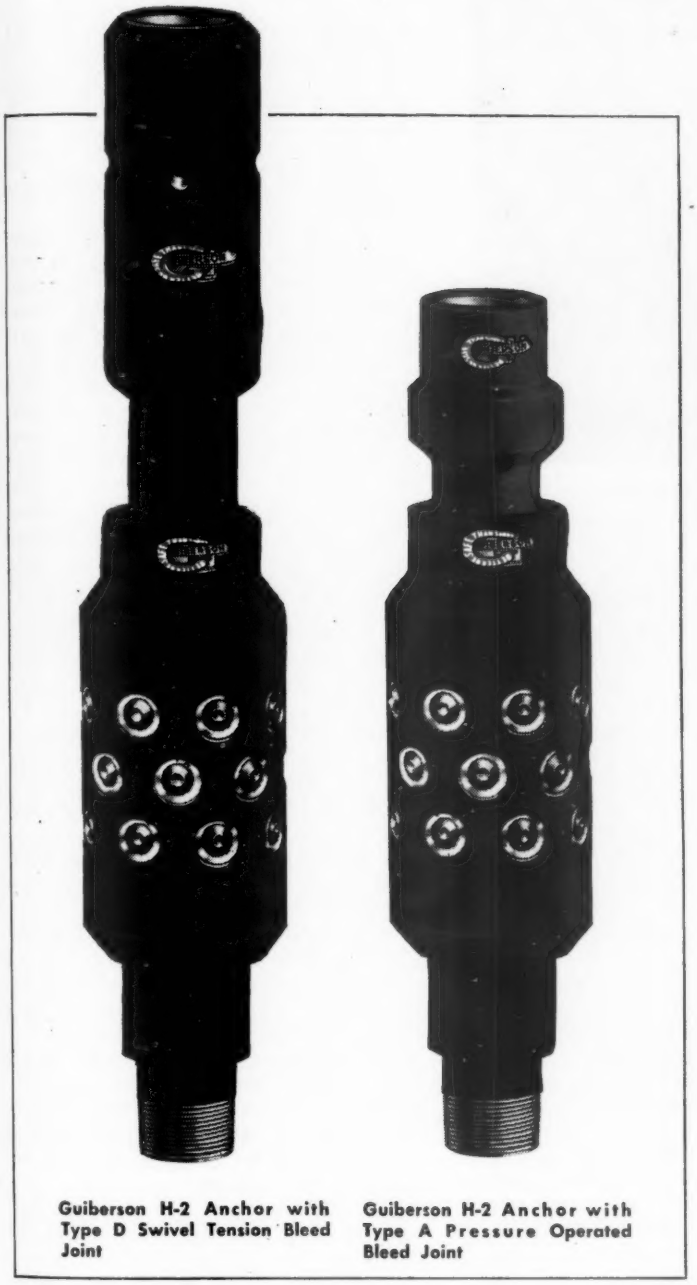
EXCLUSIVE

The Author



J. Thurman Green has recently completed his nineteenth year with Sun, the last sixteen of which have been in the safety department. In 1944 he was made director of safety for the production division in which position he continues. Stationed in Dallas, his is the responsibility of coordination of training for Sun employees from Canada to the Gulf of Mexico. The greatly reduced accident rate stands as a testimonial to his ability and application.

STOP BREATHING



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Guiberson H-2 Anchor with Type A Pressure Operated Bleed Joint

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Automatic action — no manipulation of tubing string is necessary with the H-2. As soon as fluid level in tubing is higher than casing fluid level, a series of *individual piston slips*, operating hydraulically and independently of each other, put a positive grip on the casing. Right from the start you save with the H-2 anchor. You save on first cost because the H-2 is exceptionally low cost. You save on crew time and money because the H-2 is reliable in operation — easy to set and release. You save wear and tear on your string — start lifting more fluid at lower cost.

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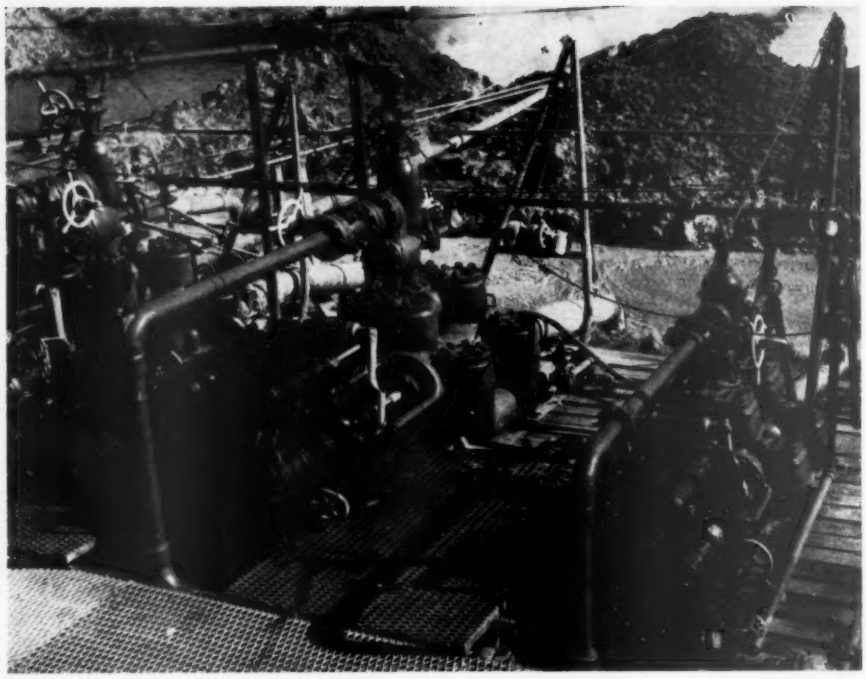

MUD PUMP installation used at Sun's Hankamer No. 2. Note suction line winches and expanded steel grating around pumps.

would be most beneficial to them individually, and the prevention of damage to equipment would be advantageous to the operator. For a few years thereafter, accident experience in the drilling industry was up and down, but generally speaking was being improved gradually each year.

In 1948, a manual rate of compensation insurance in Texas was $8.35 per one hundred dollars payroll. In 1949, it was $7.96; in 1951, it was $7.26, indicating a slow but sure decline in accident experience. Then, in December 1952, the manual rate jumped to $10.05 per one hundred dollars payroll.

Beginning about mid-year 1950, however, the industry began experiencing a marked increase in injury experience. At the same time the Compensation Act of Texas had been changed somewhat, allowing greater benefits to injured workmen, and there was an increase in medical costs, all of which naturally accumulated as a greater cost to the insurance carrier and rig owners. During the last few years, also, wages for rig personnel have increased. With this added to the compensation increase, it is costing much more money to drill wells from the compensation angle alone, and not including other techniques developed in well drilling and equipment use.

It is a proved fact that the rig operator who is making an effort to control personal injuries in his operations will spend much less money in insurance cost and equipment replacement than the operator who does not pay too much attention to injuries or their causes. On the last published information by the Petroleum Section of the National Safety Council, (year of 1951,) and using the formula specified by the American Standards Association for computing industrial injuries, the frequency rate in the drilling industry for companies who had 500 employees or more was 41.0 per cent, and the severity rate was 4.60 per cent. In those companies with 100 to 500 employees, the frequency rate was 50.3 per cent and the severity rate was 6.12 per cent. The companies employing 100 or less employees had a frequency rate of 87.5 per cent and a severity rate of 8.93 per cent.

The experiences quoted are for those companies who report their injury experience to the National Safety Council only and may not be a true representation of the entire drilling industry; however, from these facts it seems that the larger companies are making quite an effort to minimize their injury experience, whereas the smaller companies apparently are not doing quite as well along this line. For the drilling industry as a whole, there are many more operators who own from one to five rigs than there are operators who own more than five rigs, yet the insurance rates are based on the industry average.

The management of Sun Oil Company recognized many years ago the necessity of reducing injury experience to employees and controlling and reducing the loss in equipment, not only for the purpose of enjoying a better insurance rate, but for the welfare of the employee himself. Following the desire of top managment, a program aimed to reduce our injury frequency was launched.

Progress was slow for a while and employees still clung to the idea of being rugged individualists, but as time went on and the effort to control injuries became more intensified, we began to have fewer injuries, costs from an insurance angle began to decrease, and a marked decrease in damaged equipment or equipment replacement was noticed. This was accomplished through group safety meetings with all employees and numerous conferences with superintendents, tool pushers, and drillers with reference to improved working practices, guarding of certain pieces of drilling equipment, care and maintenance of all equipment, and creating a sincere desire on the part of all employees to increase their knowledge of their work for their personal benefit as well as lessening the cost per foot of drilling to the employer.

All supervisory personnel are encouraged to be alert continually to employees' ideas of improving work conditions and efficiency of drilling operations and the value of properly instructing and training new employees as they come to our jobs. Our company has a very high regard for all its employees, and each man employed has been carefully screened and is hired with the idea that he will have a permanent job. Therefore, the new man is quite willing to be a part of a team, and with instruction and encouragement from his supervisor, makes a sincere effort to play his part well.

The desire on the part of all employees to protect themselves and each other has helped to improve the safety and efficiency record enjoyed today by Sun. In 1945, our company's frequency rate was 76.13 per cent and the severity rate was 19.11 per cent. This has been gradually decreased to a low frequency rate of 16.17 per cent and a severity rate of .36 per cent. There have been some years that our experience was worse than others, but it has been gratifying to know that the experience gradually has been getting better each year, even considering the increased benefits of the Texas Compensation Act and the rising medical costs. Also during this period of years from 1945 to the present, we have experienced a very marked decline in damages to rig quipment, and through proper care and maintenance, maximum wear has been obtained from all types of equipment.

The manufacturers of drilling rig equipment and all other types of oilfield equipment have played, and are presently playing, a big part in the petroleum industry's safety work by improving the construction of all equipment they manufacture. Safety engineering now is a prime factor and a part of each engineer's design.

All company drilling rig employees wear hard hats and steel toed safety shoes. These two items alone have prevented many, many serious injuries. Goggles of various types are always available on each rig for use when any type of work is undertaken where there may be the slightest possibility of eye injury. All employees are encouraged to wear well fitted and suitable clothing and the necessary hand protection. Supervisors do not tolerate horse play, and the

properly trained worker realizes the dangers attendant to this childish activity and does not desire to have any part in it.

The company management has certainly played a big part in making working conditions more desirable for the rig employee. First aid kits and salt tablets are standard equipment on each rig, and everyone is encouraged to take salt tablets in hot weather and use the contents of the first aid kits should they receive a small scratch, cut, or bruise. Even though these items mentioned are of great value, the real effectiveness of our safety work comes through the safety meetings mentioned above, at which time there are free discussions on many ways of operation around the rig, and the ideas of all concerned are weighed both pro and con. The supervisors encourage employees to make known their opinions regarding anything that can be an improvement on their respective jobs. A safety engineer is usually present at such group meetings, and he too has something of an educational value that is an aid to self-preservation.

Drillers and tool pushers often call short meetings at times when they think the need of such a meeting is necessary. In other words, at times when certain jobs are in progress that may be unusual, he will get his crew together, outline the job to be done, and safest and most effective ways are agreed upon.

Fire extinguishers are standard equipment on each rig for the control of possible oil or gas fires, either large or small. But with good housekeeping, both on the rig floor and on the entire location, the possibility of a fire is minimized. Drillstem tests, for obvious reasons, are always made in the daylight hours.

Derrickmen on company rigs are never allowed to ride the blocks up or down the derrick. This one point has been controversial among many rig operators, but we have never heard of a man falling off a derrick ladder, while on the other hand there are known instances in the industry when men have fallen from the blocks or missed their step and fell while trying to get on or off the blocks. All derrickmen also are required to wear safety belts while working in the derrick.

We do not believe that barge drilling adds any additional hazard to the employee as far as the actual drilling practices are concerned; however, such problems as boat transportation, getting on and off boats, loading and unloading equipment from boats or barges, and the storing of equipment of various kinds of the drilling barge do present certain hazards to employees. Also there is the possibility of equipment damage that is usually not present on land jobs. We feel that through careful planning these additional hazards can be overcome. Our experience has proved that a fraction more than 98 per cent of all personal injuries sustained by drilling rig personnel are human errors — that is, an error on the part of the individual or his co-worker. This leaves a fraction less than 2 per cent of personal injuries that are caused by things beyond the control of the employee.

By proper inspection and maintenance, all equipment such as ropes, chains, wrenches, break-out tongs, wire lines, etc., can be replaced or repaired before breaking and possibly causing injury to someone or damage to other equipment. This maintenance and inspection is an every day problem and is accepted as routine in drilling operations. Many times, weaknesses in pieces of equipment have been found by timely inspection and corrected when they would have caused serious injury had they gone unnoticed.

Various chemicals and artificial muds now being used offer a possibility of burns or other ways of incapacitating an employee, providing they are not handled right. This potential hazard is usually overcome by employees knowing exactly what the contents of the mud are, its dangers, and exactly how it can be handled safely. If additional personal protective equipment is needed, it is provided for the employee by the company.

All the above mentioned facts, with the sincere desire on the part of supervisor and employee alike to continually improve their work practices, tend to make proper safety planning and execution a "must" in oilwell drilling.* * *

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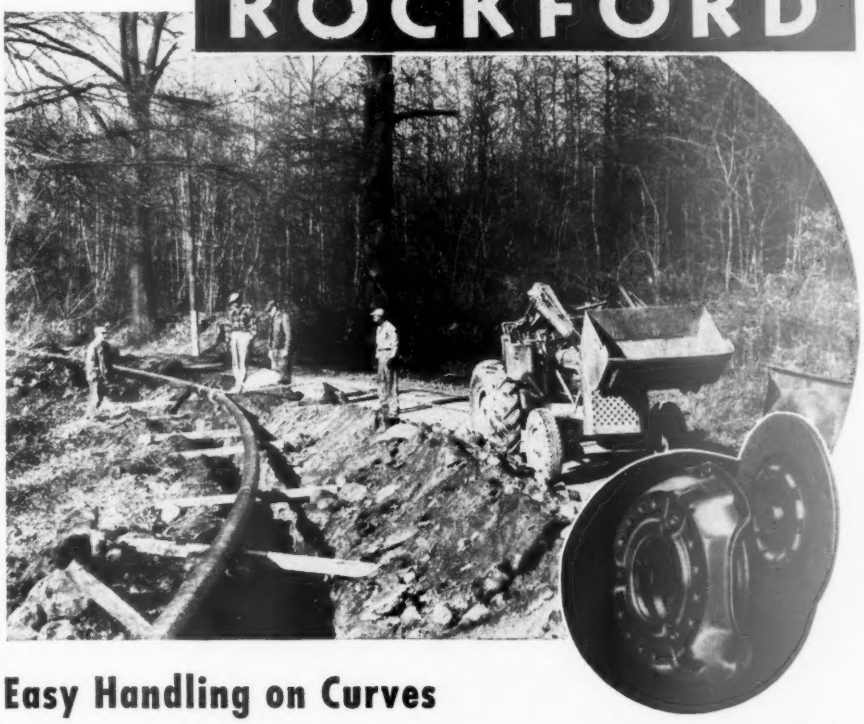

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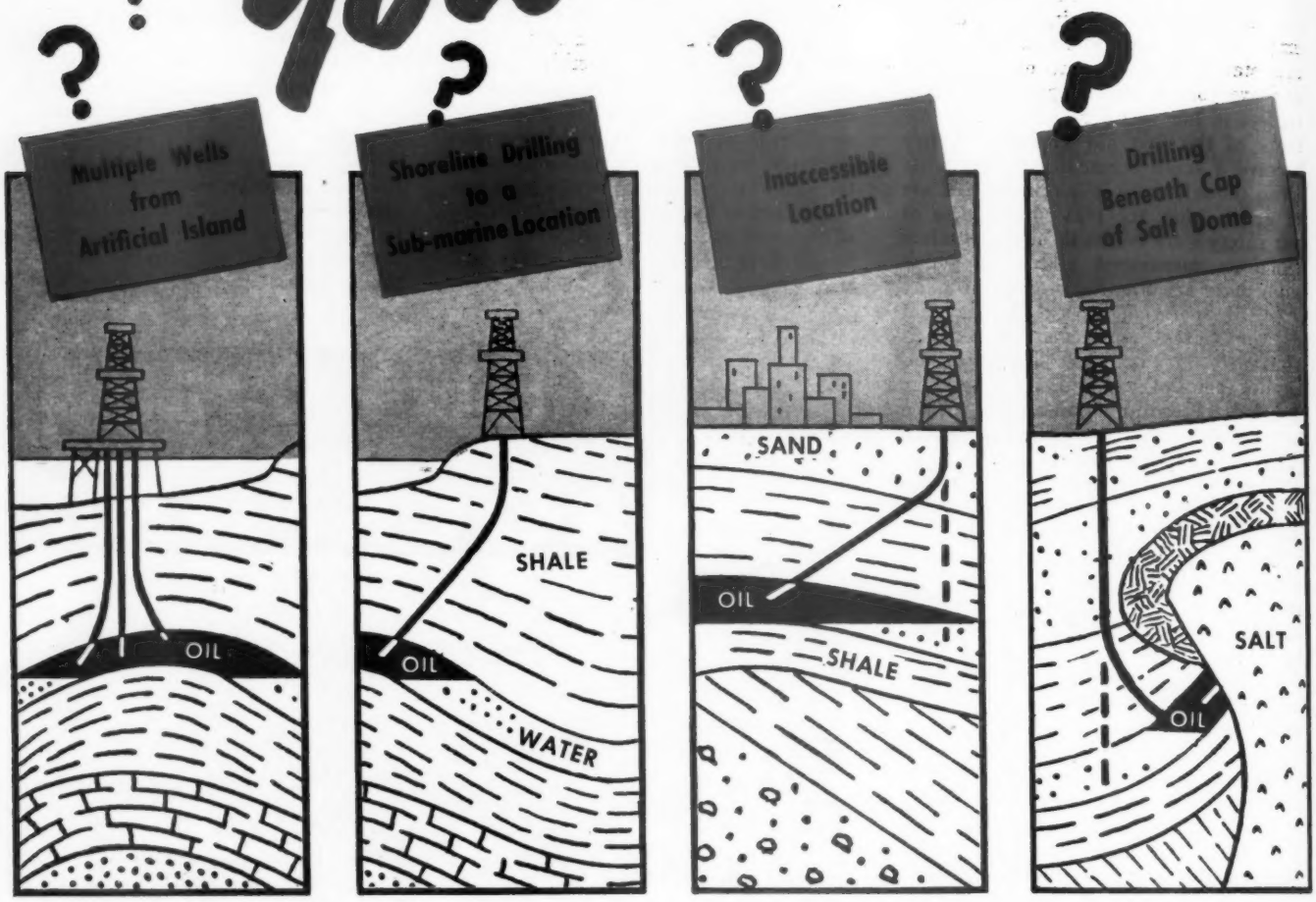

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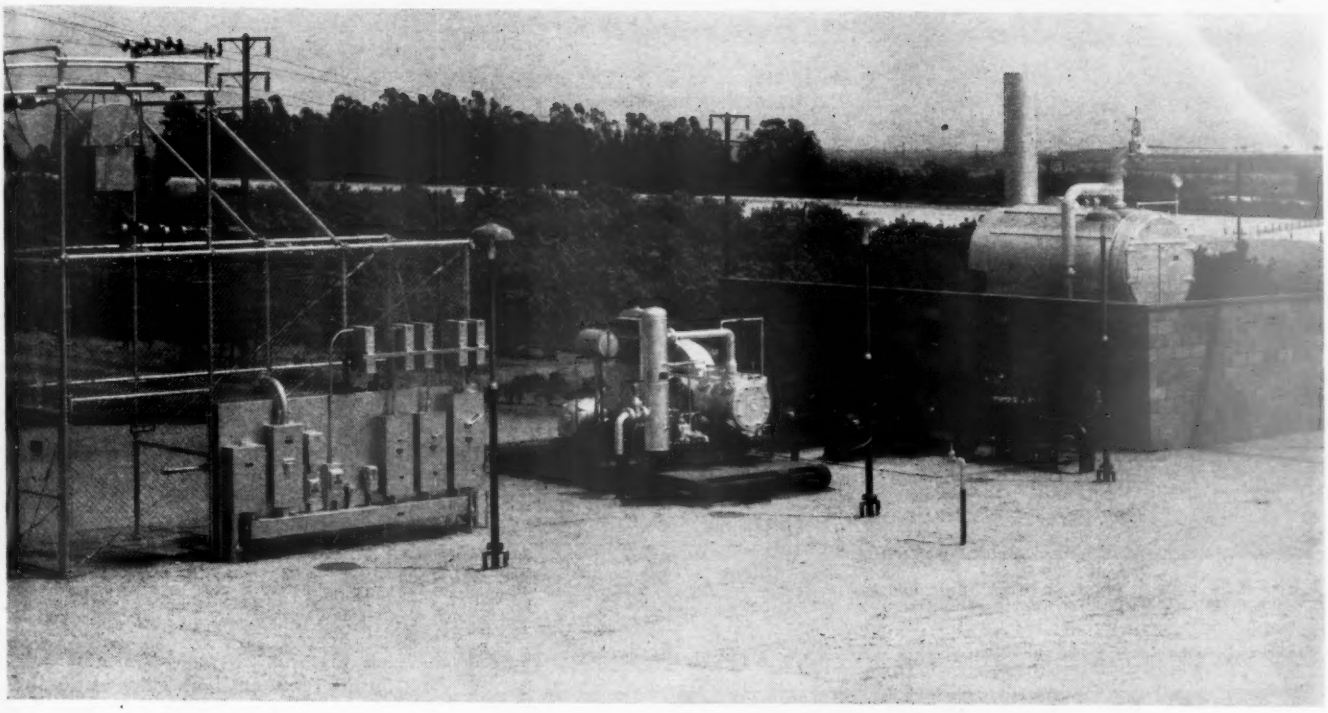

CORNER of the yard, showing power transformers, vapor recovery compressors, and shipping pumps.*

Automatic Trap Farm Starts Pushbutton Era

Self-operating valves, meters, testing devices, and recorders make this interesting station one of the West's most modern

RICHARD SNEDDON*

PRORATION of crude oil from any central collecting system back to the individual wells from which it has emanated, has been for the petroleum industry almost since its birth a costly and bothersome process. This is particularly true on leases in which there are a considerable number of wells with water contents of varying quantity and characteristics. An accurate measure of the gross and net production of each well in such instances has not been possible until comparatively recently excepting by the uneconomical and tedious method of providing two rundown tanks per well and separately gaging, testing, and shipping one while the other is being filled.

This system, of course, required a heavy investment in lines, tankage, and pumps, with a corresponding overplus of personnel, all of which could not be justified in many cases because the production of certain wells was insufficient to warrant such overhead. The operator, thus, began a sort of dispersed centralization in which small groups of wells were combined, with each group being produced into common storage, and by various means prorated back to the individual wells. Then came the utilization of fluid flow meters in the flow lines of the wells and periodic sampling at the same spot to provide water content and gravity, all of which simplified the process in some ways but still left some complications. I can remember about 20 years ago covering reams of paper with algebraic symbols in an effort to prorate the total accumulation of a central gathering station back to its eight or ten wells, on the basis of meter runs and flowline samples. I can remember, too, that this mathematical binge wasn't altogether effective, flowline samples being what they are.

All that is changed now, however, and we seem to be heading right into the long predicted era of completely automatic gaging, sampling, testing, and pumping. Out on its Puente lease in the Brea-Olinda field of Southern California, Shell Oil Company recently built a trap farm that is about as fully automatic as it could be. This set-up provides self-operative measuring and testing facilities for some 40 wells on the Puente lease, together with auxiliary tankage for checking the gaging and testing units when necessary, and for establishing the flow characteristics of new wells. It should perhaps be mentioned before going further that aside from the necessity of maintaining accurate records of individual well production in order to make proper accounting of oil and gas production to the lessors (if any), it is now thoroughly recognized that individual well conditions must be clearly defined in order that wells can be produced in conformity with established engineering principles. This, of course, means the proper gas-oil ratio among other things, all of which combine to indicate the conditions that must be maintained to acquire the maximum ultimate yield per well.

Returning now to the plant layout, the trap farm portion of the installation provides automatic testing facilities for the individual wells following the preliminary series of manual tests to which all new wells are normally subjected. For these manual tests, there are a three-

*Pacific Coast Editor.

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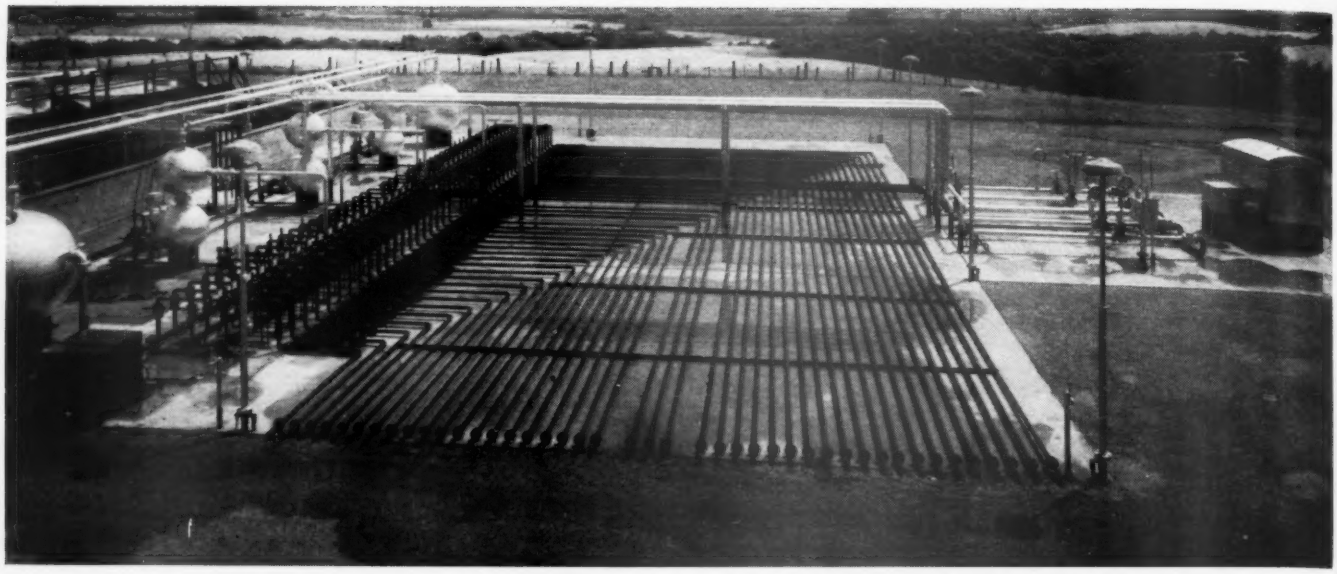
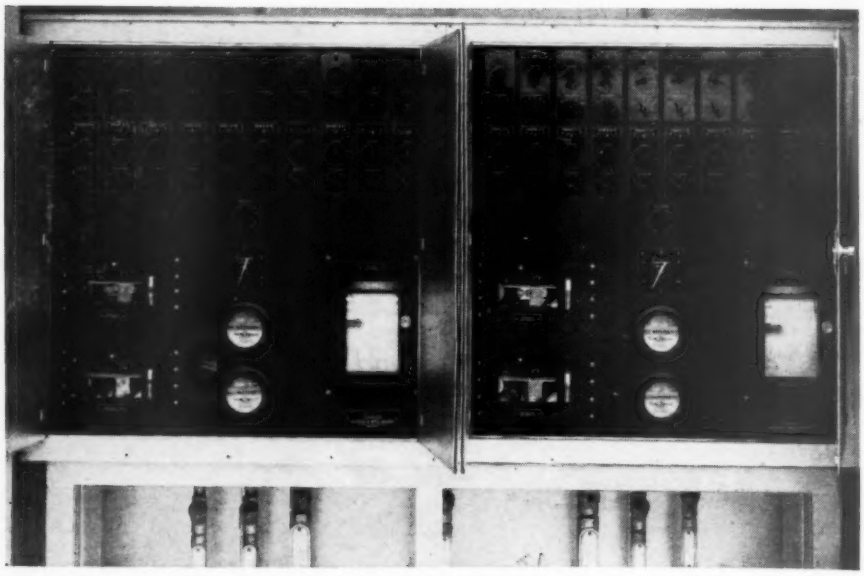
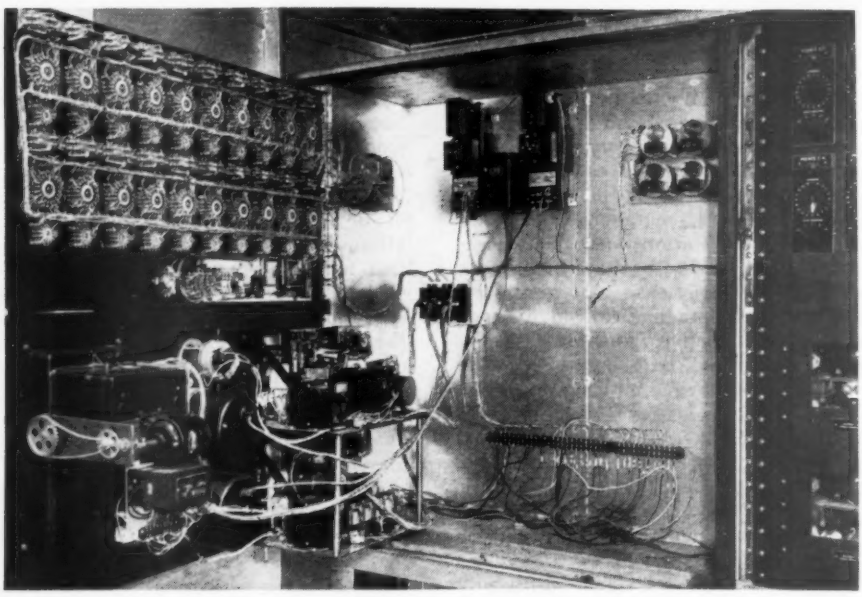


GENERAL view of plant, showing 3-line manual testing manifold, and two banks of 20 lines that are an integral part of system.



FRONT of control panels and recording instruments.



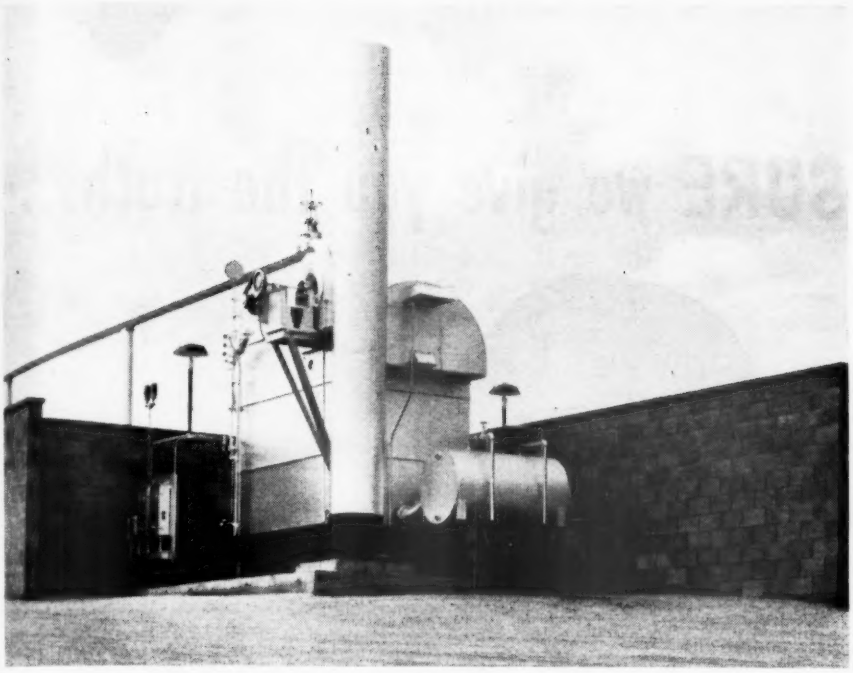
CONTROL panels from rear, showing components.

well manifold, a gas separator, and a 250 bbl tank. On both sides of the three line manifold are banks of 20 lines, making an additional 40 altogether, which come directly from the producing wells, and are in turn manifolded and integrated into the system in such a manner that in a predetermined sequence and for a predetermined length of time they are each in turn diverted by air-cylinder operated three-way plug valves from the bulk header into the test header.

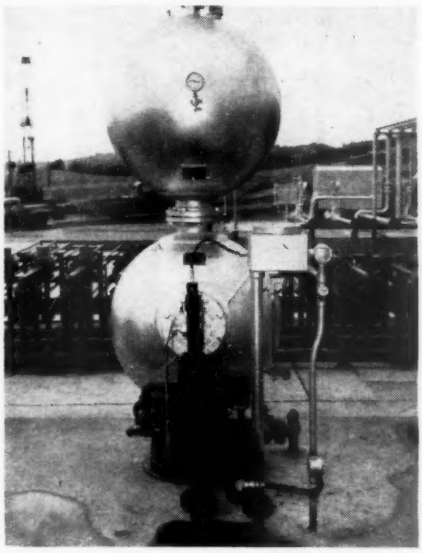
Other automatic devices are two test oil-gas separators, each of which is equipped with an automatic mechanism for determining the water content of the oil; a meter for measuring the volume of fluid; and a meter run with a wide range integrating instrument for measurement of the gas volume. These with two 250-bbl tanks, used to check the accuracy of the fluid meters and the cut recorders, and two panels that carry the switching and recording mechanisms, constitute the heart of the automatic trap system.

On the panel board are individual time and sequence selector switches that determine the duration of the test period, (O, 4, 8, 12 or 24 hours), and the order in which the wells will follow each other into the test manifold. In other words, if all of the wells were subjected to a 4 hour test in sequence, it would take just about 3 days to complete the round. A jeweled light at the panel board indicates which well is being tested at any particular time and an automatic reset clock tells how long the test has been in progress.

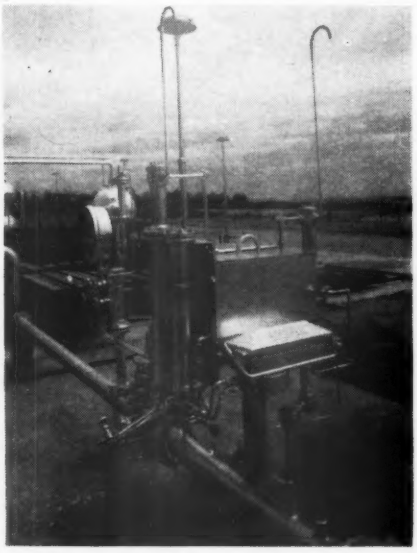
When the oil from a particular well is directed to the test header it first passes through the oil and gas separator and the gas which comes off at the top is routed through a 4-in. meter run to which is attached a special wide range, integrating gas-flow totalizer. This latter sends an 0.1 Mcf signal to an automatic printer counter on the control panel and the gas volume becomes a matter of printed record. The oil, with



STEAM heater that facilitates dehydration of incoming wet oil.



GAS SEPARATOR with cut recorder for separated oil and remote recording of oil volume.



GAS from separator is routed through this wide range flow meter and volume is remotely recorded.

whatever water it may contain, travels through an electronic cut recorder and thence through the volumetric meter and an oil valve to the wash tank. The travel of the cut recorder chart is actuated by selsyn motors mounted on the fluid meter and in the control panel and registers the percentage cut on a strip chart. This, being continuously recorded and integrated with the volume meter, provides an opportunity to take cognizance of changes in the character of the oil and to weigh the percentage over the total run. The total volume of oil and water indicated by the meter is also transmitted to the control panels by selsyn motors and recorded to tenths of a barrel by an automatic printer counter.

The mechanisms are so interrelated that when a test run is concluded, the counters are reset to zero, and the next well in turn switches itself into the testing system. At the conclusion of each run, the three strip charts located on the panel board bear imprints showing the well code number, the oil flow, and the gas flow, during the four hour period. The cut, as already intimated, is continuously recorded.

Through a 20-well master switch any well may be temporarily excluded from the automatic system to permit manual gaging and sampling for calibration of the metering and cut devices. This exclusion is accomplished by setting the master swtich at the code number corresponding to the well to be manually tested. This results in the well, which is at the time in the automatic testing

AUTOMATIC plug valves, air operated from control panel, that divert well flow from bulk header to test header at predetermined intervals.

manifold, being withdrawn and replaced by the one selected. During the manual operation, the impulse counters and timers remain inactive and at the conclusion of the operation, the master switch is reset at the off position, whereupon the well that was originally in the automatic manifold is returned to it, the impulse counters and timers become active again, and the unexpired term of this well's normally prescribed automatic test period is completed. Incidentally although a well is being manually tested, the measurements indicated by the meters and cut recorders may be noted and used for calibration purposes.

It has been found that there is a close relationship between the automatically recorded cut and gross readings and the manually obtained measurements, the difference being less than 1 per cent. Up to the time of writing, however, the gas metering equipment had not been finally calibrated so that a check of the overall accuracy of the operation could not be made. The engineering and design of the plant was carried out by Bill Faulk, mechanical engineer.

The automatic set-up has not yet been long enough in operation to permit an accurate determination of its economics but there is every indication that it will eventually fully justify the prognostications of the engineers responsible for its design and installation. As in all such innovations there are minor adjustments to be made and modifications of method to be instituted before the operation as originally contemplated may be expected to run on smoothly and uninterruptedly. Even the most myopic, however, is bound to see in the Puente trap farm a preview of the automatic operations of the future. The trend is definitely in the direction of complete self-functioning and this particular installation is a long step towards that objective. Experience here will no doubt dictate the way of further progress along the same line, and eventually bring us a bit nearer to the perfection that we can never quite reach but for which, nonetheless, we must always continue to strive. * * *

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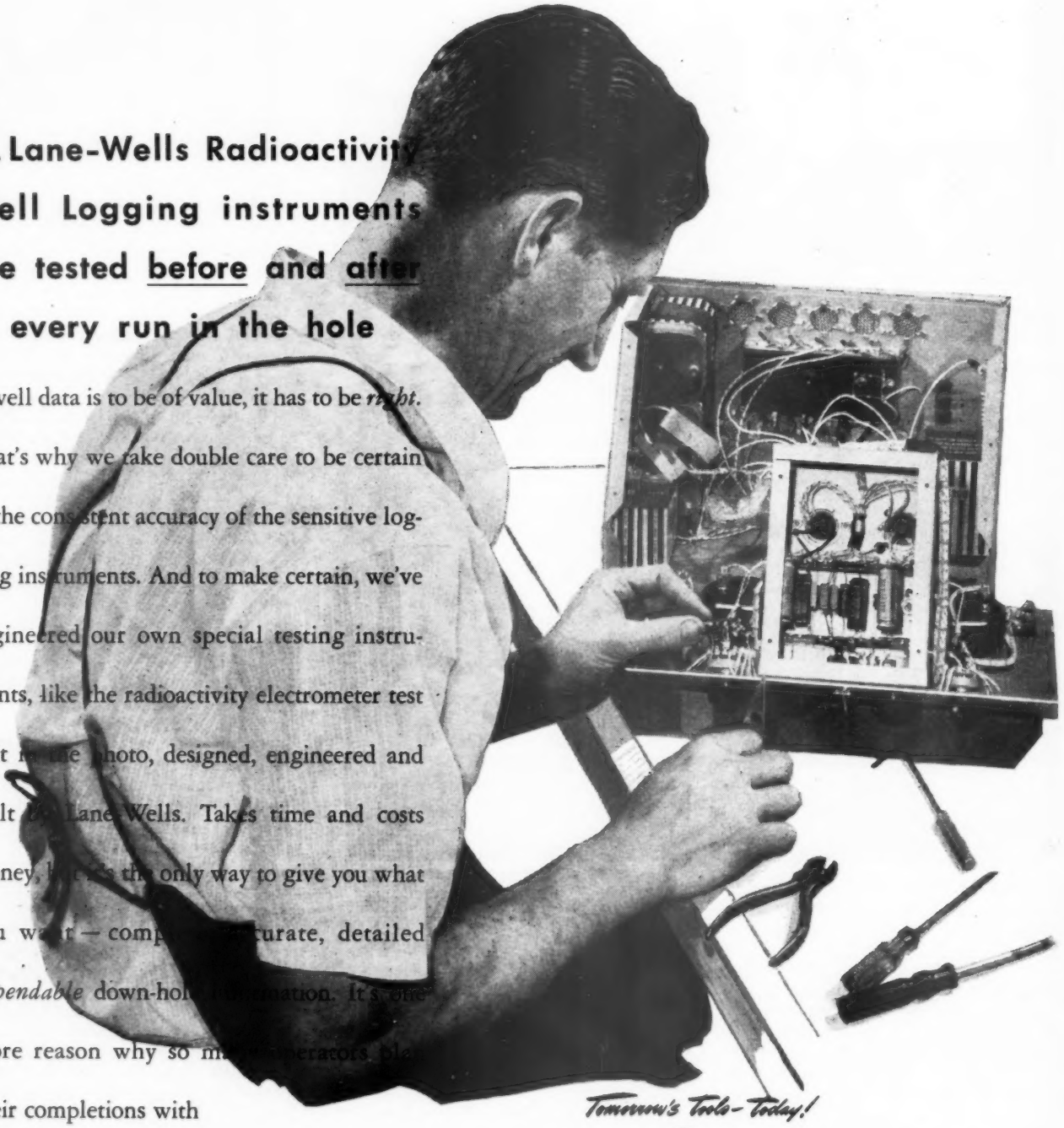

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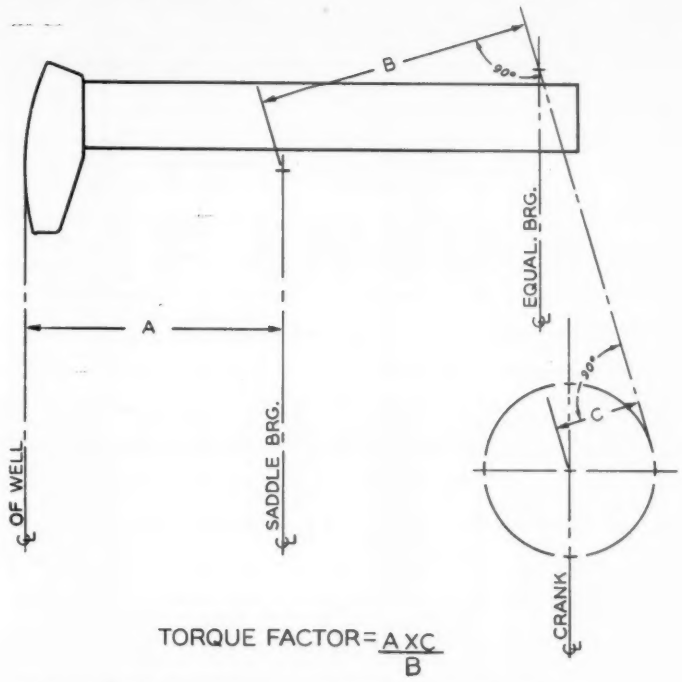

FIG. 1. SCHEMATIC diagram shows dimensions used in API method for calculative torque factor.

Using Dynamometer to Calculate

Pumping Unit Peak Torque Loads

Operation within API load specifications is important in securing full service from unit gear reducers

KENNETH N. MILLS

THE full importance of keeping the pumping unit speed reducer torque load within its API capacity is seldom realized until several reducers have been severely damaged due to overload. The nature of the damage resulting from excessive load is dependent on the magnitude of the overload. Minor degrees of overload will cause gear teeth to wear at an excessive rate. This excessive wear will reduce the useful life of the reducer and may lead to tooth breakage failures. Major overloads will cause a rapid deterioration of the working faces on the gear teeth and early gear tooth breakage failures.

Basically, the torque load imposed on a pumping unit speed reducer is a function of the magnitude and nature of the well load, the degree of perfection of counterbalance, and the geometric characteristics of the pumping unit. It may be influenced by engine impulse loads and torsional vibrations. Use of heavy flywheels on single cylinder engines will help reduce the magnitude of the engine impulse loads imposed on the speed reducer. They may, however, aid in establishing the conditions required to impose dangerous torsional vibration loads on the speed reducer. If torsional vibrations exist, they will materially increase the speed reducer loading and may cause premature failures.

When the initial pumping unit selection is made, both the well load and counterbalance must be based on theoretical calculations. These calculations are based on assumptions that represent the average values of several variables and may not yield accurate results for a particular well. Extensive investigations of the accuracy of the existing well load formulas have shown that none of the formulas are exact, and, at best, are only good estimates. The problem of estimating counterbalance encompasses all of the variables involved in calculating the well load. It is further complicated by the nature of the sucker rod vibrations, because the location of the maximum and minimum loads in the stroke cycle control the magnitude of the peak torque load. For these reasons calculated values of the peak torque load must be viewed as approximations.

After a well has been placed on the pump and has reached stabilized pumping conditions, all of the above variables can be measured with a dynamometer. The peak torque load can be calculated from the dynamometer data. To assure accurate results the geometric characteristics of the pumping unit must be considered in these calculations. The API has established a simple method for considering the geometric characteristics of the pumping unit in these calculations. This method uses a series of values called torque factors which are the numerical value of the effective crank arm at various points in the stroke cycle. Equation for the torque factor and the dimensional values of the terms used in this equation are shown in Fig. 1. Values of the torque factors are functions of the pitman length and relative locations of the various pivot points in the pumping unit mechanism. Each type of pumping unit construction has its own geometric characteristics. The effect of the relative locations for three types of pumping unit construction are illustrated in Fig. 2. Dimensional characteristics of these units are defined in Fig. 3. One of the predominating factors influencing the torque factor is the pitman length as related to the crank stroke. This relationship can be defined as a ratio L/R, which is the length of the pitman divided by the crank stroke radius. The effect of varying this ratio on the maximum value of the torque factor for the unit construction defined in Fig. 3C is shown in Fig. 4. In this illustration it will be noted that the maximum value of the torque factor, and therefore the true peak torque, decreases as the L/R ratio is increased. This is to be expected because the torque multiplication incident to unit geometry would be eliminated if the pitman length were infinite.

The first step in accurately calculating the peak torque load is obtaining a good dynamometer card and measuring the magnitude of the counter-balance force

The Author

Kenneth N. Mills received a BS degree in mechanical engineering from Rice Institute in 1933. After he graduated he joined American Manufacturing Company of Texas and became chief engineer of that company. In 1940 he joined Bethlehem Supply Company as chief engineer. During the war he became works manager for Texasteel Manufacturing Company and later assistant chief mechanical engineer of Emsco Derrick and Equipment Company at Houston. He joined Ideco as machinery products manager at Columbus in 1949. His present position is chief engineer with Walter O'Bannon Company, Tulsa, Oklahoma.

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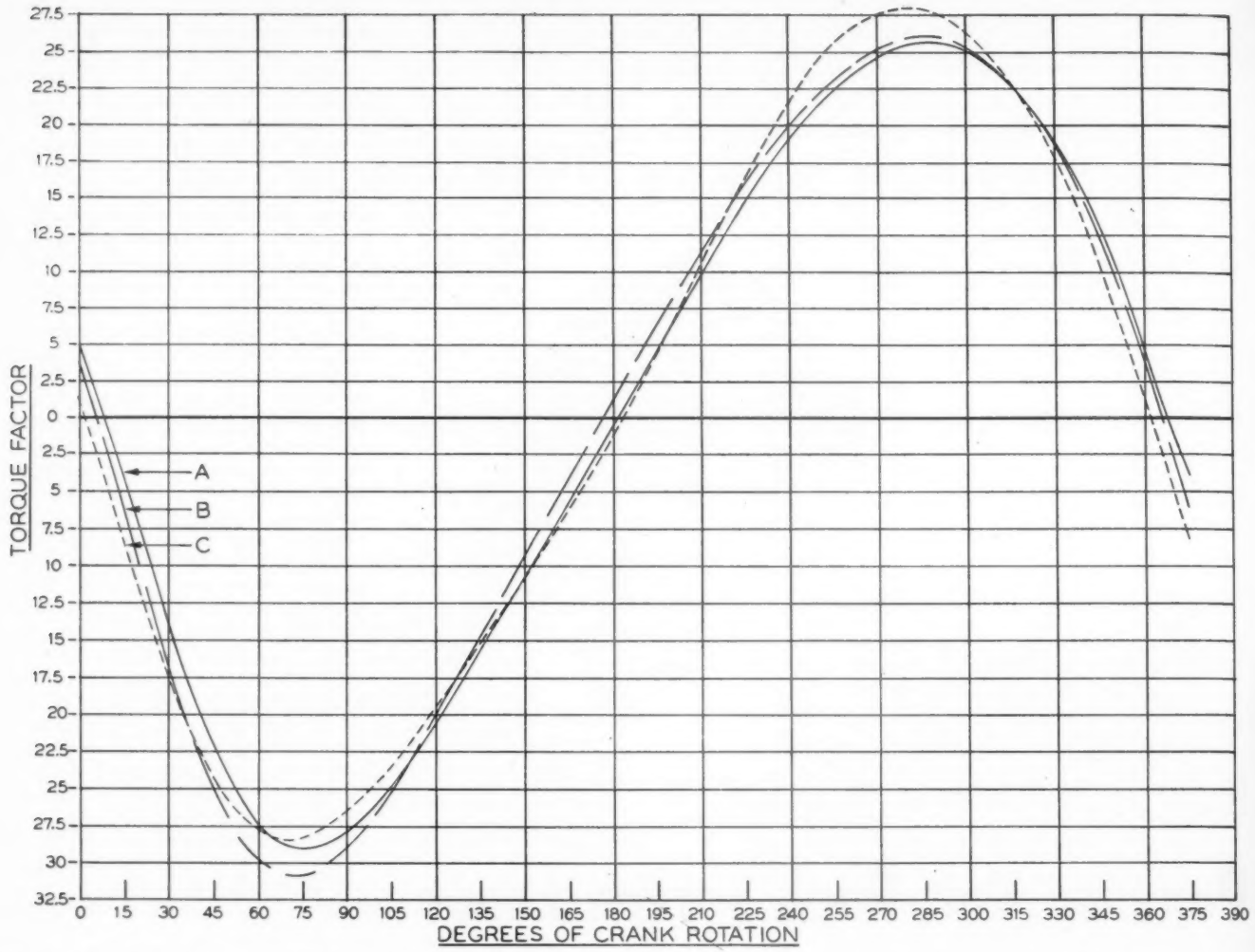

FIG. 2. EFFECT of pitman length and bearing and crank location on torque factor. Various combinations shown in Fig. 3.

at the polished rod. Amount of counterbalance must be measured to eliminate variations from the manufacturer's counterbalance charts incident to casting weight variations. This force can be measured after the well load card has been taken by stopping the unit on the up stroke with the cranks in a horizontal position. To achieve accurate results the cranks must be horizontal, or at some known angle from the vertical, when the counterbalance force is measured. The crank position and the direction of crank rotation should be noted on the dynamometer card. When the cranks are in position the polished rod is "clamped off" and the rod load transferred to the stuffing box. Then the polished rod is secured to the well head with a chain. After the polished rod is secured from motion in either direction, the pumping unit brake is released. This imposes the full counterbalance force on the dynamometer and the magnitude of this force can be recorded on the dynamometer card by rotating the recording drum. The counterbalance force will be recorded as a horizontal line through the well load diagram. If the well is reasonably well balanced, this line will be located near the center of the diagram.

The first operation in preparing the dynamometer card for an analysis of reducer torque loads is to construct lines tangent to each end of the diagram perpendicular to the zero line as shown in Fig. 5. The distance A between these two lines represents length of the polished rod stroke. For any position of the crank the polished rod load and torque can be determined with the aid of a torque factor chart for the unit. A typical torque factor chart is shown in Table 1. In this chart the position of the crank is shown in Column 1, and the corresponding positions of the polished rod for the various stroke lengths of the crank are shown in Columns 2, 3, and 4. The polished rod positions are shown as a percentage of the total stroke above the bottom of the stroke. The direction of crank rotation is assumed to be clockwise. If the direction of crank rotation is counter-clockwise the chart must be read from the bottom up, keeping in mind that the rod positions and torque factors are identical for zero and 360 deg. Location of a point on the dynamometer card corresponding to a given crank angle can be determined by multiplying the distance A by percentage of stroke corresponding to a crank angle. The distance thus determined corresponds to the dimension B in Fig. 5. As the force producing torque load on the speed reducer is instantaneous difference between the well load and the counterbalance force, this force can be measured directly on a dynamometer card with the counterbalance force recorded on the card. This force corresponds to the distance C in Fig. 5, and

TABLE 1. Pump unit stroke and torque factor.

1	2	3	4	5	6	7	8	9	0
		Position of rods†				Torque factor			
Position of crank deg.*		Length of stroke, in.				Length of stroke, in.			
		24	34.1	44.2		24	34.1	44.2	
0		0	0	0		1.05	2.29	4.14	
15		1.09	.51	0		2.82	3.64	4.22	
30		6.52	6.14	5.14		6.70	10.07	13.40	
45		15.15	15.85	15.58		9.93	15.32	21.35	
60		27.90	28.95	29.80		12.14	18.52	26.15	
75		41.30	43.50	45.60		13.09	19.46	26.55	
90		55.40	58.20	60.50		12.59	18.19	23.90	
105		68.50	70.80	73.25		11.28	15.80	19.59	
120		79.70	82.10	83.60		9.49	12.65	15.18	
135		88.80	90.50	91.30		7.14	9.27	10.82	
150		95.60	96.00	96.50		4.67	5.87	6.79	
165		98.50	99.30	99.30		2.06	2.52	2.86	
180		100.00	100.00	100.00		.36	.72	.95	
195		97.80	98.25	98.10		2.87	3.79	4.75	
210		93.40	93.80	94.40		5.25	6.89	8.35	
225		86.60	87.60	88.30		7.26	9.74	11.95	
240		77.90	79.00	80.50		9.05	12.23	15.18	
255		67.00	69.10	70.50		10.38	14.39	17.98	
270		55.40	57.30	59.10		11.25	15.69	19.85	
285		43.15	45.30	47.20		11.57	16.22	20.79	
300		30.80	32.75	34.95		10.95	15.79	20.56	
315		19.57	21.25	23.08		9.76	14.22	18.99	
330		10.15	11.25	12.62		7.55	11.45	15.93	
345		3.26	3.84	4.54		4.51	7.42	11.15	

* Position of crank is the angular displacement measured clockwise from the 12 o'clock position, viewed with the well head to the right.

† Position is expressed as a percentage of stroke above lowermost position.

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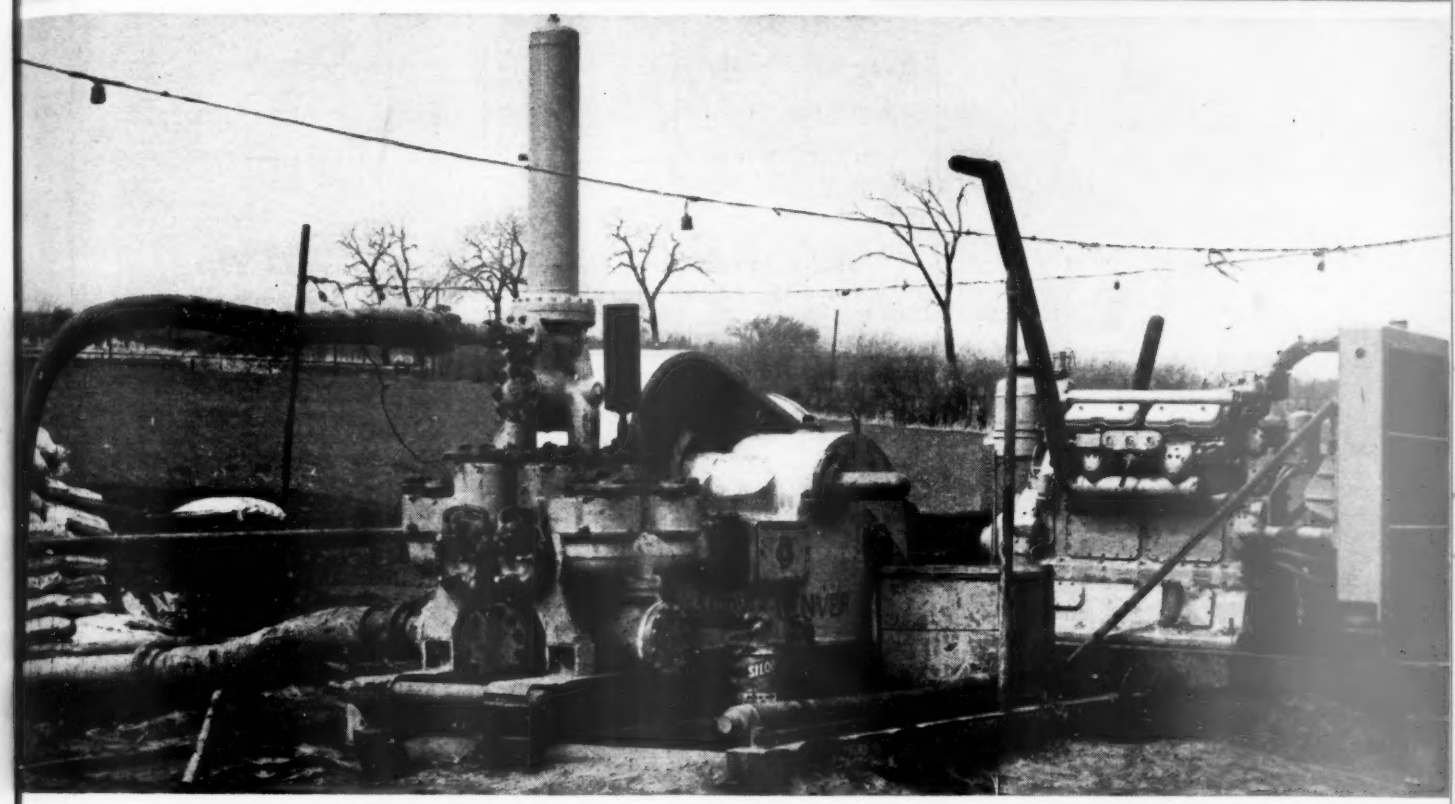

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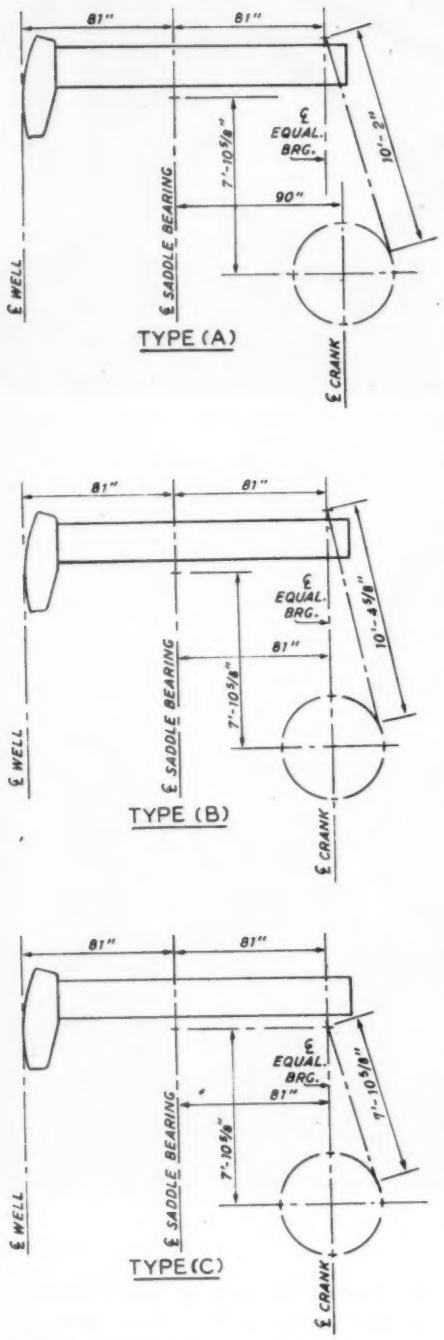


FIG. 3. AVAILABLE combinations of pitman lengths and bearing and crank positions.

can be evaluated by multiplying this distance by the dynamometer spring constant. Referring back to Table 1, it will be noted that torque factors for the various lengths of crank stroke are listed in Columns 6, 7, and 8. These torque factors are the total effective lever arm lengths for the various crank strokes. When these values are multiplied by the corresponding value of C and the dynamometer spring constant, the product is the torque load imposed on the speed reducer at that instant.

The following example will illustrate the use of this chart.

Dynamometer Spring Constant = 7900 lb per inch
Crank Stroke = 44 in.
Crank Rotation = Clockwise

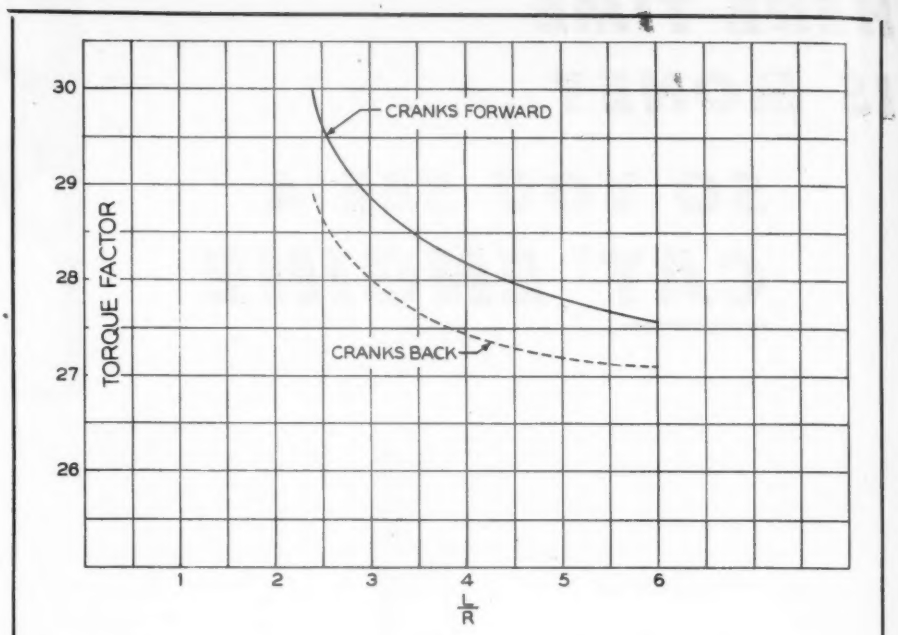


FIG. 4. EFFECT of changes in pitman length (L) to crank stroke radius (R) ratio on torque factor for unit construction shown in Fig. 3-C.

Crank Angle = 60 deg
A = 3.07 in.
% Stroke = 29.8
B = 3.07 × 29.8 = 0.915
Torque factor = 26.15
By measurement C = 0.46 in.
Torque = 0.46 × 7900 × 26.15 = 94,000 in. lb

To determine the magnitude of the peak torque load, the above calculations must be repeated for all points near the mid-stroke position on both the up and down portions of the stroke cycle. If the shape of the dynamometer card is such that a peak load exists between two tabular values of crank angle, the torque at this point should be investigated. To make this investigation, measure the distance B to the point in question. Then divide the distance B by A to determine the per cent of stroke. This per cent of stroke value can be used to interpolate in the torque factor chart, to determine the correct value of the torque factor. The torque at this point can be determined by multiplying this torque factor by the net load corresponding to this position.

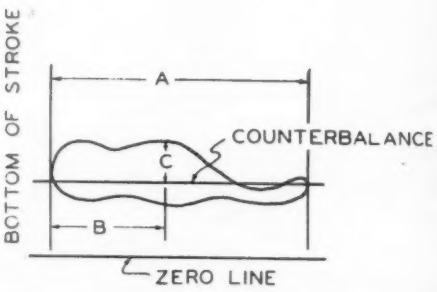


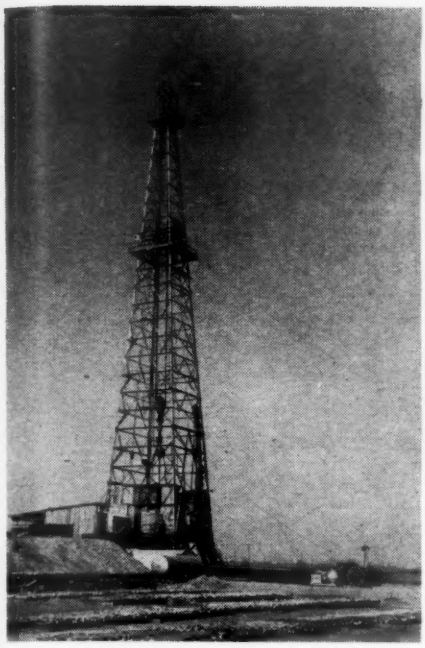
FIG. 5. DYNAMOMATIC card prepared for analysis of reducer torque loads.

If a complete investigation is made of the torque load on the reducer, the exact state of counterbalance can be determined. If the unit properly counterbalanced, peak torque on the up and down portions of the stroke cycle will be equal. If these values are not equal, they can be corrected by adjusting the position of the counterbalance line on the dynamometer card. By making this adjustment the minimum peak torque load value can be determined. Naturally, if this adjustment reduces the torque load on the reducer, a corresponding change should be made on the unit. After making a change of this type on a critically loaded pumping unit, the well and counterbalance should be reweighed to check results of counterbalance adjustment. * * *

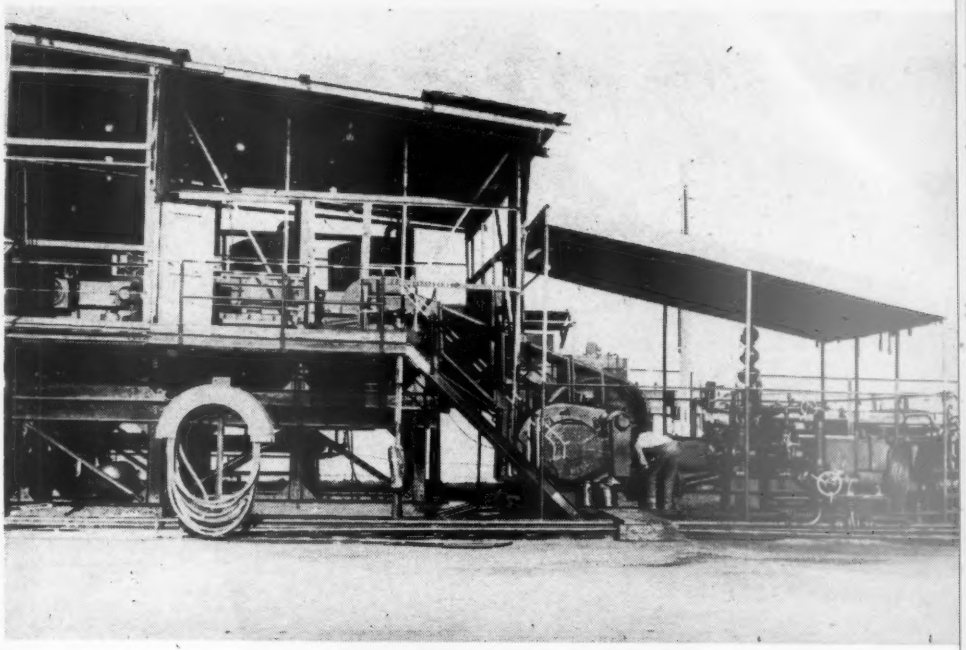
Uranium Unit Planned By Kerr - McGee Oil

Kerr-McGee Oil Industries, Inc., has announced that it will build a new type uranium ore processing plant at Shiprock, New Mexico. The project will cost $3,000,000, a company spokesman reported. G. R. Kennedy, manager of exploration for Kerr-McGee, said the new plant will take in raw ore from the company's mining operations 45 miles west of Shiprock and turn out uranium oxide, a metal. He explained this product will be sent East for further processing into a purer uranium metal.

The new plant will raise to 10 the number of uranium ore processing plants in operation or under construction in the Colorado plateau area of the United States.



OHIO OIL'S KCL A No. 72-4 in Paloma field, Kern County, California. Cores shown represent 5143 ft cored in the deep well.



POWER plant and mud pump layout at The Ohio Oil Company's record-breaking deep well in Paloma field.

Ohio Establishes

World's New Depth Record

In California

Kern County exploration passes old mark and heads for 21,000 ft

WILLIAM T. RINTOUL

AN exploratory well in the Paloma field 17 miles southwest of Bakersfield, Kern County, California, now holds the distinction of being the deepest well in the world.

At 12:48 p.m. on Thursday, August 20, 1953, The Ohio Oil Company's KCL A No. 72-4 on Section 4—T 32S—R 26E, drilled past the previous record of 20,521 ft, making hole at a 1.74 ft per hour rate, and continued prospecting ahead.

Since June 18, 1949, the world's depth record had been held by The Superior Oil Company's Pacific Creek Unit No. 1 on Section 27—T 27N—R 103W, in Sublette County, Wyoming. The Superior Oil Company's well reached total depth on that date and later after a series of formation tests was abandoned.

The Ohio Oil Company used company crews and a company rig — a National 125 drawworks with a 164-ft steel derrick and 4-½ in. OD drill pipe — to break the record. On August 23, The Ohio Oil Company's well was at a depth of 20,531 ft. A National 160 drawworks and a 192-ft derrick were used to drill The Superior Oil Company's well from 9881 ft — depth to which the well was drilled in 1947 by Dyer and Rice, contractors—to total depth of 20,521 ft.

Another world's record that Ohio's deep well might eventually break is that for deepest production, a record now held by Shell Oil Company's Weeks-Gall Unit No. 1 in the Weeks Island field of Louisiana. Shell Oil Company completed this well several months ago for 107 bbl per day and 2,911,000 cu ft of gas, based on an 8-hr gage, flowing from an interval at 17,038-17,122 ft.

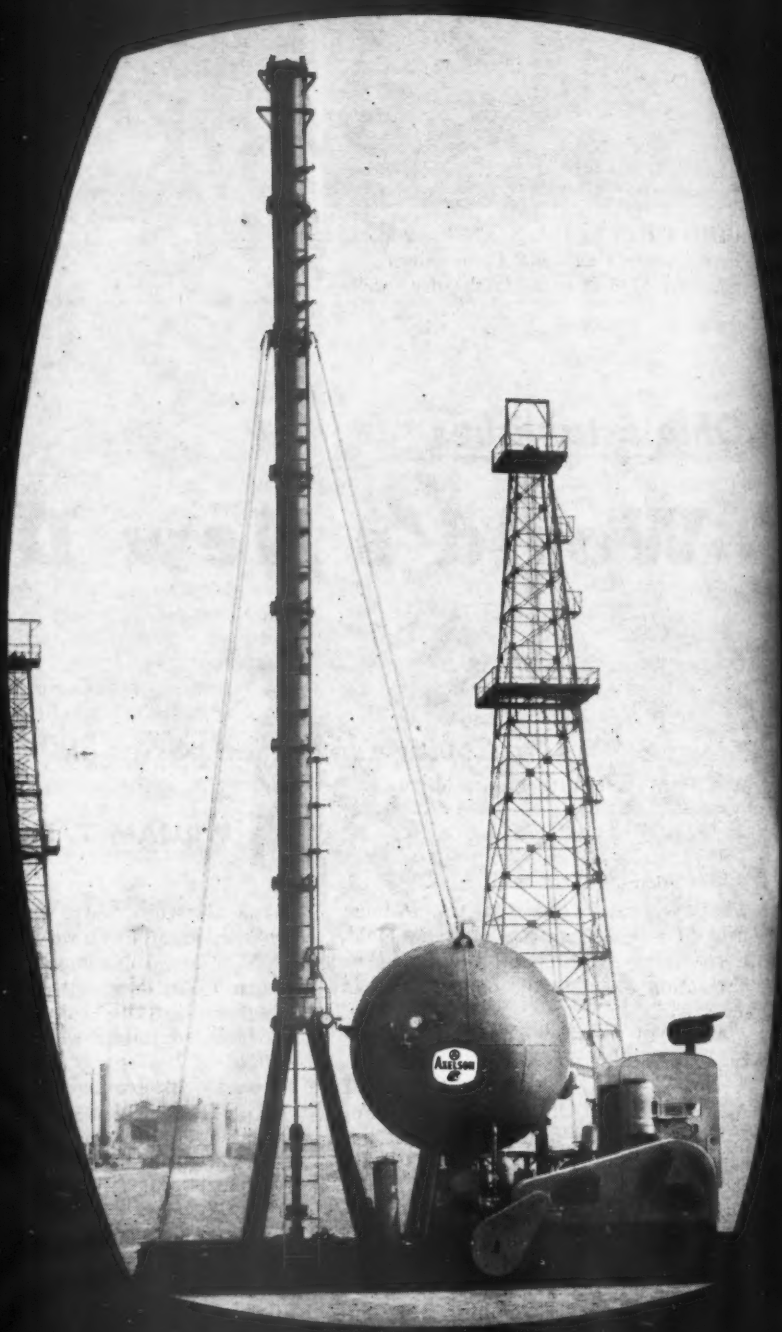
Planned as a deeper zone test for production from the Oceanic sand of Oligocene age and the Point of Rocks sand of Eocene age, Ohio's well is situated on acreage leased from Kern County Land Company in the south central portion of the 14-year-old Paloma field. Present production in the field is from sands of Miocene age from depths ranging from 10,650-11,440 ft, with 84 wells producing approximately 11,800 bbl-per-day of debutanized condensate, natural gasolines, butanes, and crude oil.

Both of the objective zones are prolific producing horizons in fields near McKittrick, about 27 miles northwest of the Paloma drill site. Also, two years before The Ohio Oil Company spudded in to drill its deep test, the Eocene sand was proved productive from a depth of 15,530 ft at another operator's well in the Wasco field, 32 miles northwest of the Paloma field. It is of interest to note that six months after The Ohio's well was spudded, Richfield Oil Corporation proved up production from Eocene sand in the Wheeler Ridge field, 15 miles southeast of Paloma, with a discovery

EXCLUSIVE

"Prove it"

A major oil company wanted a comparative report on a Beam Unit versus an Axelson Long Stroke Unit for a certain well. These excerpts show pertinent figures proving the efficiency of the Axelson unit. More production, less rod stress, increased pump life, greatly reduced seat and ball wear, less liner wear in any one spot are some of the advantages to be expected.



The Axelson Hydraulic Long Stroke Pumping Unit has 30,000* lb. load capacity and up to 350 fpm polished rod travel.

Available in:

Model H-0312 — STANDARD DUTY — for well applications requiring 69 or less Engine Brake Horse Power.

Model H-0313 — HEAVY DUTY — for well applications requiring 70 or more Engine Brake Horse Power.

*Operation of Unit limited to either 30,000 lbs. polished rod load capacity or 14,000 lbs. load range.

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TABULATION SHEET

AXELSON MANUFACTURING COMPANY

Division of Pressed Steel Car Company, Inc.

UNIT	84" BEAM UNIT	HEAVY DUTY AXELSON HYDRAULIC LONG STROKE UNIT
PUMP DEPTH	6200 FEET	6200 FEET
TUBING SIZE	2½"	2½"
PUMP BORE	2¼"	1¾"

ROD STRING

SIZE	PERCENT	FOOTAGE	SIZE	PERCENT	FOOTAGE
1"	28	1760'			
⅞"	31	1920'	⅞"	33	2030'
¾"	41	2520'	¾"	67	4170'

STROKES PER MINUTE	17	6½
NET UPWARD PLUNGER TRAVEL PER MIN.	1021½"	1937"
PEAK POLISHED ROD LOAD	26,750 lbs.	15,700 lbs.
MINIMUM LOAD	5,500 lbs.	8,800 lbs.
LOAD RANGE	21,250 lbs.	6,900 lbs.
MAX. SUCKER ROD STRESS	34,100 psi	30,700 psi
PRODUCTION AT 100% VE	595 B/D	690 B/D

Close-up of Cooler on H-0313 Model. Cooler maintains hydraulic oil temperature at 165° F. safeguarding against carbon formation and subsequent restriction of movement or breakdown of hydraulic fluid

t!

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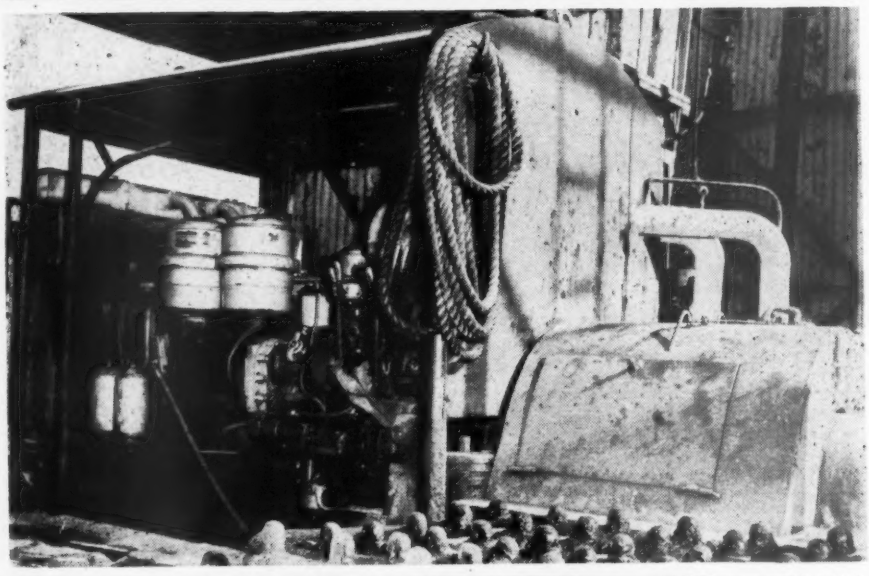
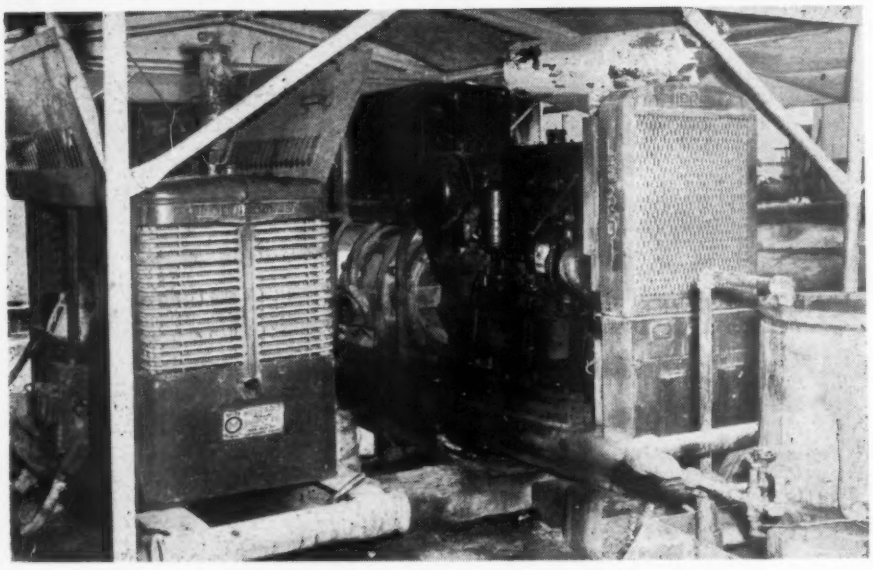
XUM





LIGHT plant, bottom, uses 4-cylinder International LeRoi generators.

TWIN G.M.C. diesels, center, are the only diesels on rig, and they drive rotary table through an Oilwell torque converter.

POWER plant, top, is composed of four 350-hp Superior gas engines that power drawworks at well in Paloma field.

that was generally believed to be one of the biggest finds in California in more than 15 years.

In the absence of previous deep tests in the Paloma field, it was difficult to foresee how deep Ohio's well might have to go to reach its objectives. The deepest test previously drilled in the field had been a Superior Oil Company well that was drilled to 14,400 ft, bottoming in the Miocene zone without finding production below the Paloma sand. Geological considerations indicated that a depth somewhere between 18,000-22,000 ft would be necessary to evaluate the Oceanic and the Point of Rocks sands.

Obviously the drilling of such a deep well presented a variety of problems. First, of course, was the selection of rotary equipment powerful enough to handle the drilling work. Second, it was necessary to select drill pipe that could be used at great depths and bits that could cut through the hard, compact shales and sandstones expected in deep formations. Third, the projected deep drilling project called for the use of special engineering and drilling methods, designed to make operations as free of trouble as possible.

On October 1, 1951, Ohio Oil Company began rigging up a big company rig, which in the past five years had been used on two projects — a deep test in the West Branch field of Ogemaw County, Michigan, and a 13,818-ft duster on the Mitchell lease near Arvin, Kern County, California. At 3 a.m. on October 23, the drilling crew on morning tour spudded in the well, which on its 668th day of continuous, 24-hour-per-day operation established a new world's record.

The steel derrick is 164 ft high with a 30-ft base and 14-ft, 8-in. substructure. Assembled from prefabricated angle steel, the derrick weighs 67,037 lb. Fully rigged, the derrick, engines, drawworks, crown block, traveling block, and hook can readily hoist and control 250 tons.

One portion of the substructure, 9-ft 3-in. high, supports the 21-ton load of four 350-hp gas engines, which power the drawworks. Each of the gas engines has a radiator that is 7 ft, 7 in. high and a cooling system capacity of 70 gal. Lubricating system for each of the engines has a capacity of 30 gal.

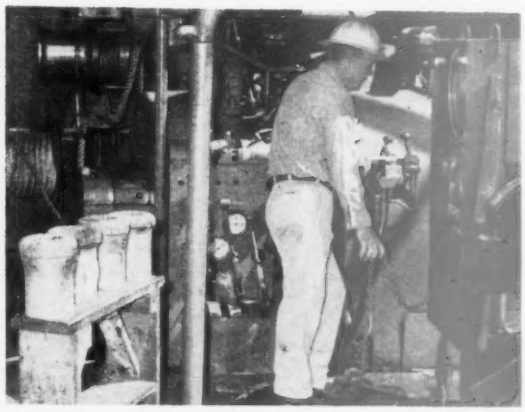
An important consideration in the selection of gas as a fuel for the rotary was the availability of supply. In the 1930's Ohio Oil Company completed six gas wells in the Paloma area from a sand found at 5180-5239 ft. All but two, KCL A No. 1 and KCL A No. 6, had been abandoned by the time the deep test was planned. One of the still active wells has been used to supply drilling fuel for the deep well, whereas the other is maintained as a standby for drilling fuel.

Another portion of the substructure, 13 ft 3 in. high, supports the drawworks, which weighs more than 38 tons. Engine and drawworks substructure is separate from the derrick floor

XUM

Diamonds cored all but 95 ft. of the 5143 ft. of core.

Diamond bit pulled at 20,246 ft., on bottom 107½ hours and made 113 ft. of hole.



Drilling ahead with diamond bits. Four core bits used shown on bench at left.

Ohio Oil uses diamonds to reach new depth record

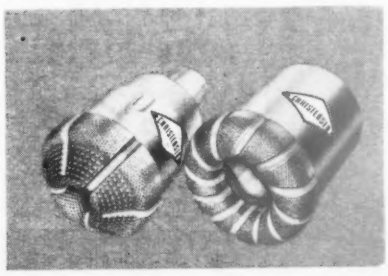
Extensive use of diamond bits to cut through hard sand and shale formations proves economical for Ohio Oil Company in the California Deep Test

On August 20th at 1:20 p.m. the Ohio Oil Company not only broke the record for drilling the deepest well in the world, but also set a new depth record for diamond coring. Previously diamond core bits were used on the Superior's record depth. It may even be said that this is the record for the extent of diamond coring, for at the time the record was broken 130 cores had been cut, a total of 5143 ft. cored. While 95′ were cut in the upper beds with conventional coring bits the remainder was cut with diamond core heads. All but 23 ft. of the core was recovered, a loss of less than one-half of 1%.

For sometime the Ohio Oil has been using diamond bits in drilling this deep test. On this record well not only the advantage of diamond coring (virtually 100% core recovery) has been proved but also the economy of using diamond drilling bits which have operated on bottom for periods up to eight days. Virtually all the hole made below 14,000 ft. has been made with diamond bits.

We sincerely hope that Ohio Oil Company breaks the only remaining record left to break, the record for deep production. The diamond bit industry is proud of the part it has played in drilling the deepest well in the world.

(Diamonds were also used on the Shell Oil Company's Weeks Gall Unit 1, today's deepest producing well, 17038 ft. 17122 ft.)



Christensen Diamond Bits distributed in California by Mercury Oil Tool Company, 11420 South Alameda Street, Los Angeles, California.

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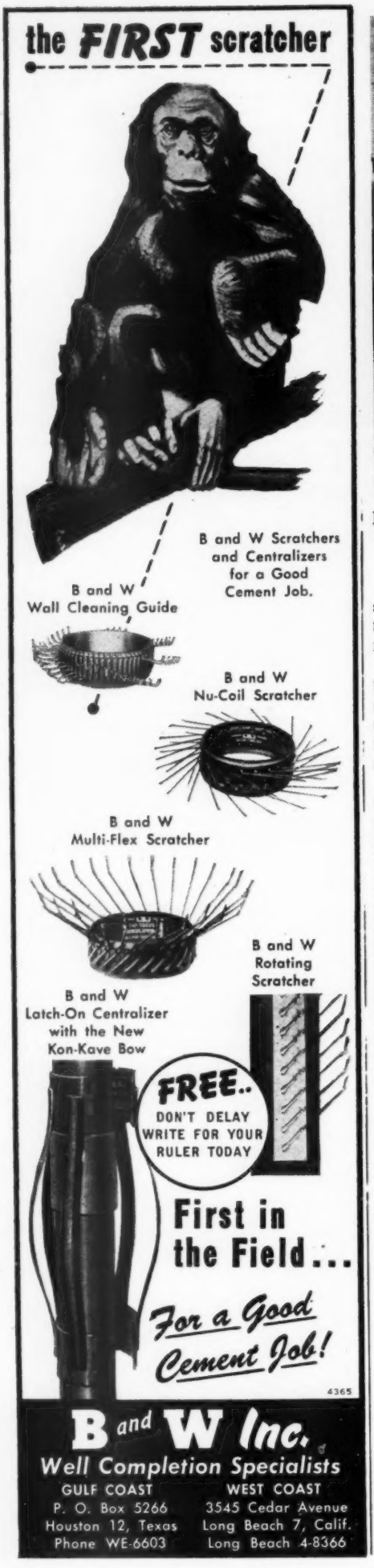
LESS COST PER FOOT CHRISTENSEN DIAMOND PRODUCTS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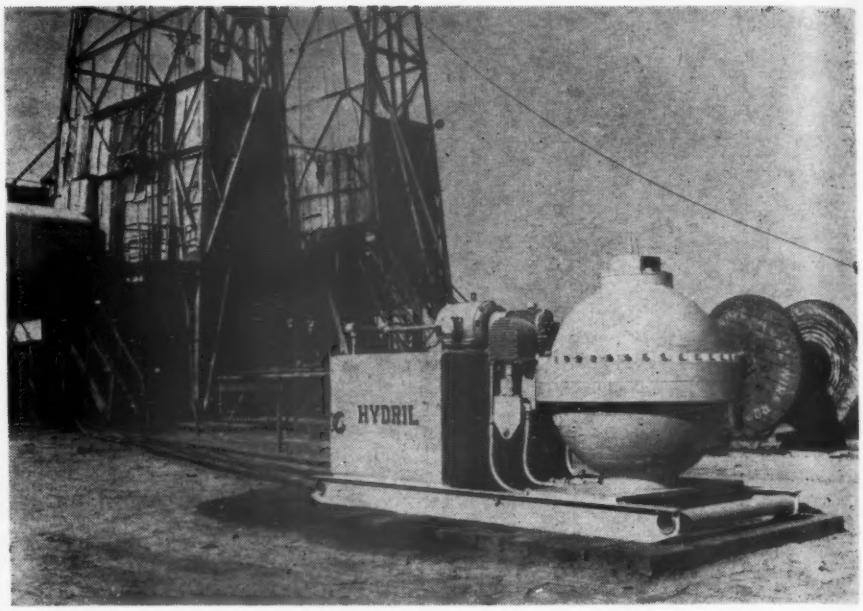


HYDRIL accumulator — electrically powered pump maintains 1500 lb pressure for blowout preventer.

substructure so that the vibrations from the heavy machinery will not be transmitted to the derrick and derrick floor.

Legs of the derrick are extended so that the substructure independent of the derrick can be moved in or out. A special safety feature of the substructure is the ease of access to the cellar and blowout prevention equipment.

Hazardous cross-bracing of a conventional substructure is eliminated by cantilever supports. The substructure has casing or drill pipe support capacity of 300 tons and a rotary table support of 150 tons plus additional reinforcement. The pipe rack is 40 ft long and 16 ft wide. It is made up of four prefabricated steel units, 3 ft 9 in. high, 8 ft wide, and 20 ft long.

There are five safety platforms between the floor of the rig and the crown block. A run-a-round provides the safety platform on the outside of the derrick at the level of the 120-ft high "fourble" board, where the derrickman racks the stands—four 30-ft singles to a stand—when they are coming out of the hole.

A gin pole atop the derrick is used principally for placing the 8560-lb crown block during rig-up work. Capacity of the five-ton traveling block is 360 tons. The block has five 88-in. manganese steel sheaves. The hook weighs almost a ton and has a carrying capacity of 300 tons.

The engine group and drawworks are set on a separate steel substructure four ft below derrick flood level. Guards over each coupling form a non-skid step. Ample space is provided between engines for easy access and safe working conditions.

Mud pumps include two 350 hp pumps and one 250 hp pump. One 350 hp mud pump, driven by two of the 350 hp drawworks engines, is used for circulating while another is operated on a stand-by basis. The 250 hp mud pump is used for mixing. Mud pumps are powered by two gas engines identical to those in the four-engine group that powers the drawworks.

Twin 150 hp diesels—the only diesels on the rig—drive the rotary table. They are linked by a torque converter to drive the rotary table.

Blowout equipment includes one all-purpose head, designed to make a complete shut-off around any size pipe or a blind shut-off, and two hydraulic, ram-type heads. Rams of one of the hydraulic heads close around the drill pipe; rams of the other hydraulic head offer a complete shut-off. Blowout equipment is made up on 9⅝-in. casing set at 10,947 ft.

There have been no major breakdowns in the gas engines, which have run almost continuously—an estimated 90 per cent of the entire operational time—since digging rat hole for the deep test at Paloma.

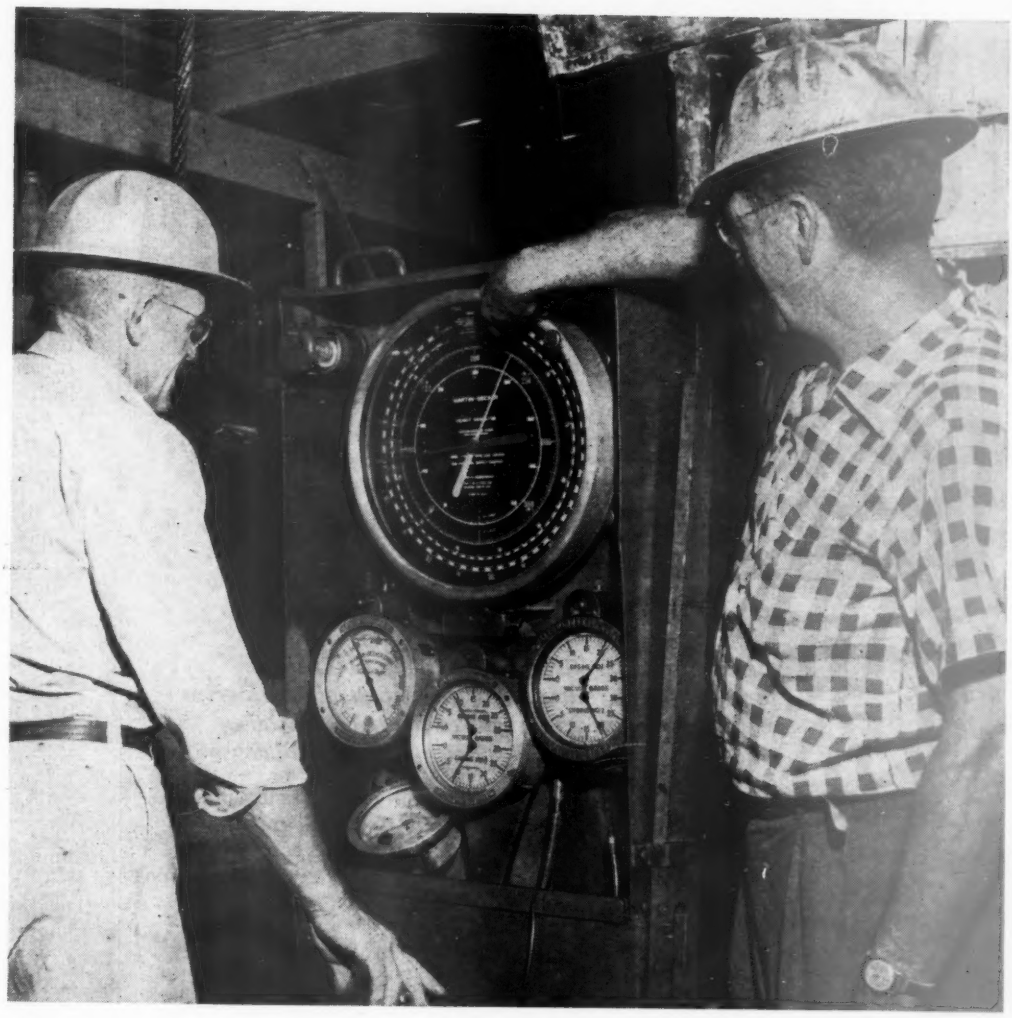
Prior to spudding in the deep test, Ohio Oil Company cemented 18-in. conductor pipe to 61.57 ft K.B. Twelve and one-quarter inch hole was drilled and then reamed to 17-in. to the casing point at 1431 ft, where 13⅜-in., 54.5-lb, J-55, LT&C casing was cemented with 875 sacks of common cement.

Twelve and one-quarter inch hole was carried all the way to 10,947 ft except in the interval at 6670-6765 ft, which was cored with an 8½-in. conventional core-barrel for the purpose of inspecting a possible gas sand. Electric log was run and the interval at 6731-6765 ft tested wet.

After passing through the field's presently productive horizon at 10,038-10,320 ft, it was necessary to cement casing that would protect this horizon and also be strong enough to withstand possible production usage.

One of the heaviest casing strings ever run in California, and perhaps in the world, was run on February 5, 1952 —279 joints of 9⅝-in., 43.5-lb, 47.0-lb,

THE DEEPEST WELL IN THE WORLD



Ohio Oil Company's Paloma KCLA-72-4 **20,927 ft.** World Record Well Equipped With Martin-Decker Type "D" Weight Indicator and Ideal Wire Line Anchor Sealtite Mud Pump Pressure Gauge, two Double Vacuum Gauges and Rotary Table Tachometer. **Sept. 21** drilling ahead at approximately 1′ per hour.

27 years ago Martin-Decker introduced the first successful Weight Indicator. Since then, in all countries of the world, drilling depth records have been broken 23 times and, in each instance, not a single record has been obtained without the aid of Martin-Decker Drilling Control Instruments.

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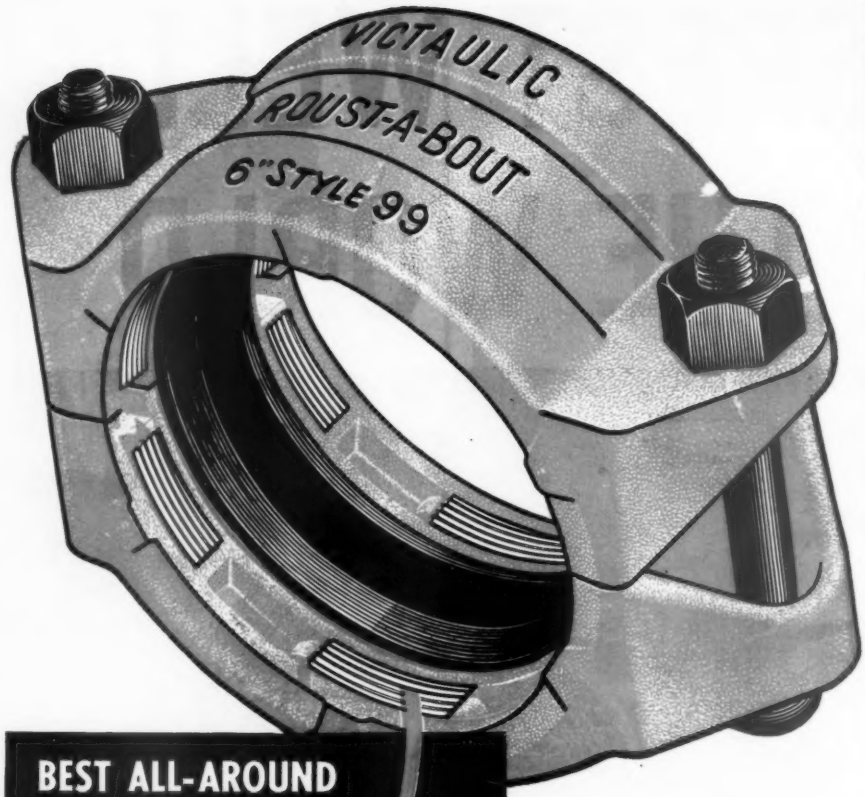

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Roust-A-Bout Couplings are just what the name implies—reliable, sturdy, adaptable and ingenious—ready for those tough field jobs where only plain end pipe is used or where the simple Victaulic Groove Method is not quickly available.

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- You *cut* and *couple* your pipe as you go!
- You can use *plain* or *beveled end* pipe!
- You can use *new* or *used* pipe!
- For use on *permanent* piping or *repair* work!
- You need only one tool—a *socket wrench!*
- Roust-A-Bouts are simple and factory finished!

For your next job—insist on the best—Victaulic Roust-A-Bouts. They're available at all Victaulic Stocking Supply Houses in pipe sizes—2", 2½", 3", 3½", 4", 5", 6", and 8".

Write today for the Victaulic Roust-A-Bout Catalog No. 44-8G.

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and 53.5-lb, N-80 Extremeline casing. Air weight of the casing string was 513,732 lb.

Purpose of running the heavy string was to give a balanced string with a minimum tensile safety factor of over two and a collapse resistance safety factor of one on the basis of 82 lb per cubic feet (11 lb per gal) mud.

Casing was run as follows (top to bottom):

5 joints, 53.5 lb.....	202.49 ft.....	10,833 lb
161 joints, 43.5 lb.....	6,248.59 ft.....	271,814 lb
39 joints, 47 lb.....	1,502.32 ft.....	70,609 lb
74 joints, 53.5 lb.....	2,999.56 ft.....	160,476 lb
279 joints Totals.....	10,952.96 ft.....	513,732 lb
Landed above K.B.....	—5.96 ft	
Landed at.....	10,947.00 ft K.B.	

Casing equipment included a "Down-Geyser" float shoe and float collar on the 44-ft shoe joint. Sixteen scratchers were placed at 10,956 ft, 10,928 ft, 10,920 ft, 10,912 ft, 10,889 ft, 10,880 ft, 10,871 ft, 10,366 ft, 10,356 ft, 10,346 ft, 10,336 ft, 10,029 ft, 10,019 ft, 10,008 ft, and 9,998 ft. Six centralizers were placed at 10,943 ft, 10,859 ft, 10,362 ft, 10,325 ft, 10,025 ft, and 9994 ft. Running time was 13 hours and 15 minutes.

Casing was cemented at 10,947 ft with a 1000-sack equivalent of 1 to 1 lightweight aggregate 4 per cent Gel and high-temperature cement mixed to 89 lb per cubic foot (11.9 lb per gal), followed by 200 sacks of neat high temperature cement mixed to 116 lb per cubic foot (15.5 lb per gal).

Three cement trucks were used. Fifty cubic feet of water were put behind two top rubber plugs which were bolted together with a magnesium bolt. Mixing time was 19 min for the lightweight aggregate and 9 minutes for the neat cement. The cement was measured and displaced with the cement trucks.

After one hours and eighteen minutes total displacement time, plugs were bumped at a maximum pressure of 1500 psi. Fourteen cubic feet of mud was bled back to set the floats. After 12 hours a temperature survey was run which indicated the top of the cement to be at 8400 ft outside the casing as compared to the calculated top of 6400 ft. When drilling out, cement was found to be at 10,892 ft, or 11 ft above float collar.

In order to drill the deep well, The Ohio Oil Company has used a combination string of 4½-in., 17.35 lb per foot, internal flush, integral-joint, vanadium steel and Grade E drill pipe. The specially designed vanadium steel drill pipe was tested at the mill and found to have a joint strength of more than 231 tons. To date Ohio has pulled over 400,000 lb, putting 13 ft of stretch in the pipe with no permanent elongation. At record depth the drilling string put a load of some 141 tons on the hook. Free weight of the drilling string at 20,522 ft is considerably more—185 tons. Heavy oil base mud in the hole, weighing about 116 lb per cubic foot, has a buoyant effect of 44 tons.

String in the hole at the time the

record was broken included 165 stands of 4½-in. drill pipe, five six-inch OD drill collars—totaling 191 ft, and a diamond drilling bit, with a bumper safety sub above the drill collars and a jar safety joint above the bit.

Hard, compact shales and sandstones necessitated the use of diamond bits and diamond core heads. From 10,947 ft downward, these special bits and core heads set with industrial diamonds have drilled practically the entire remaining hole.

One hundred and thirty cores, totaling 5143 ft have been cut—95 ft with conventional core bits and the remainder with diamond core bits. Only 11 cores—271 ft—were taken down to a depth of 13,877 ft, where nearly continuous coring was begun. Eighty-one core samples have been analyzed.

A rate of penetration log made from geolograph charts shows drilling and coring rate in foot-per-hour for each foot penetrated from 9838 ft to present depth. This log is plotted on a conventional log scale.

In general, rate of penetration for diamond drilling bits and diamond coring bits has been about 1 ft per hour in shale and 2 to 3 ft per hour in sandstone. In the case of the diamond drilling bits, bits have been left on bottom for as long as seven days at a time, while the maximum hours on bottom with the 11 conventional rock bits used for 92 ft of hole below 10,947 ft was 11 hours. Below 13,877 ft when nearly continuous coring started, the round trip time steadily increased with depth from 6½ to 11 hours.

From 15,000 ft down, the load of the drill pipe on the drilling lines called for special care of the drilling lines. Wire lines in use are 1¼-in., improved plow steel, wire center cable lines. As a precaution, a definite program of wire line care has been followed below 15,000 ft. Between 15,000 ft and 16,000 ft, the program required that the line be moved from three to five feet after every round-trip and that the line be cut 100 ft after every round-trip. Below 16,000 ft, the program required that the line be cut 100 ft after every round-trip.

Incidentally, when Ohio ran the 9⅝-in. casing, the company rigged the longest drilling line ever used in California —6000 ft of line. Since setting casing, Ohio has used line in the 5,000-ft lengths.

The Paloma deep test was spudded and drilled to 10,955 ft with a water clay base drilling mud. Weight varied from 75 to 85 lb per cubic foot (10.0 to 11.3 lb per gal) and viscosity varied from 40 to 60 seconds.

Because of the high earth temperatures increasing with depth, the use of water clay base mud was considered impractical. At 20,003 ft, a temperature survey was made that showed the temperature at that depth to be 334 F when mud was not in circulation. From 10,955 ft an oil base mud on which high temperatures have only slight effect, and which requires a minimum of maintenance, was used.

It is doubtful that Ohio could have

TABLE 1. Bit record of Ohio Oil Company's KCL A No. 72-4 Paloma field, Kern County, California.

Abbreviations: RB — Rock bit. C — Core-head. RM — Reamer. DB — Diamond bit. DC — Diamond core-head. R — Rereaming. S — Sidetracking. CO — Cleaning out.

Bit number	Type bit	Size	Depth on	Depth off	Total feet	Hours	Av ft	Explanation
1	RB	12¼	0	1431	1431	17	84.17	
2	RM	17½	0	1431	0	17		
3	RB	12¼	1431	2854	1423	18	79.05	
4	RB	12¼	2854	3661	807	15	53.80	
5	RB	12¼	3661	4451	790	14½	54.48	
6	RB	12¼	4451	4965	514	15	34.27	
7	RB	12¼	4965	5562	597	15½	38.52	
8	RB	12¼	5562	5833	271	12	22.58	
9	RB	12¼	5833	6162	329	16	20.56	
10	RB	12¼	6162	6410	248	12	20.67	
11	RB	12¼	6410	6524	114	10½	10.86	
12	RB	12¼	6524	6670	146	12	12.17	
1	C	8½	6670	6720	50	8	6.25	
2	C	8½	6720	6740	20	4	5.00	
3	C	8½	6740	6765	25	6	4.17	
13	RB	12¼	6765	6912	147	8	18.37	
14	RB	12¼	6912	7112	200	14½	13.79	
15	RB	12¼	7112	7260	148	12½	11.84	
16	RB	12¼	7260	7424	164	15½	10.58	
17	RB	12¼	7424	7500	76	8	9.50	
18	RB	12¼	7500	7617	117	13½	8.67	
19	RB	12¼	7617	7719	102	11½	8.87	
20	RB	12¼	7719	7831	112	11½	9.74	
21	RB	12¼	7831	7989	158	13½	11.70	
22	RB	12¼	7989	8085	96	13½	7.11	
23	RB	12¼	8085	8212	127	15½	8.19	
24	RB	12¼	8212	8321	109	16½	6.61	
25	RB	12¼	8321	8421	100	13	7.69	
26	RB	12¼	8421	8466	45	12	3.75	
27	RB	12¼	8466	8551	85	12	7.08	
28	RB	12¼	8551	8605	54	12	4.50	
29	RB	12¼	8605	8712	107	17½	6.11	
30	RB	12¼	8712	8774	62	14	4.43	
31	RB	12¼	8774	8842	68	15½	4.39	
32	RB	12¼	8842	8918	76	16½	4.61	
33	RB	12¼	8918	9020	102	14	7.29	
34	RB	12¼	9020	9079	59	11½	5.13	
35	RB	12¼	9079	9154	75	12	6.25	
36	RB	12¼	9154	9182	28	8	3.50	
37	RB	12¼	9182	9223	41	12	3.42	
38	RB	12¼	9223	9264	41	10½	3.90	
39	RB	12¼	9264	9334	70	11	6.36	
40	RB	12¼	9334	9387	53	11	4.82	
41	RB	12¼	9387	9439	52	10½	4.95	
42	RB	12¼	9439	9495	56	10½	5.33	
43	RB	12¼	9495	9540	45	10½	4.29	
44	RB	12¼	9540	9587	47	10½	4.48	
45	RB	12¼	9587	9619	32	10	3.20	
46	RB	12¼	9619	9648	29	9	3.22	
47	RB	12¼	9648	9679	31	8½	3.65	
48	RB	12¼	9679	9704	25	8	3.13	
49	RB	12¼	9704	9716	12	6½	1.85	
50	RB	12¼	9716	9761	45	12	3.75	
51	RB	12¼	9761	9791	30	11	2.73	
52	RB	12¼	9791	9824	33	10½	3.14	
53	RB	12¼	9824	9857	33	11	3.00	
54	RB	12¼	9857	9876	19	8	2.38	
55	RB	12¼	9876	9902	26	9	2.89	
56	RB	12¼	9902	9914	12	7	1.71	
57	RB	12¼	9914	9932	18	8	2.25	
58	RB	12¼	9932	9946	14	7½	1.87	
59	RB	12¼	9946	9965	19	8½	2.24	
60	RB	12¼	9965	9982	17	7¾	2.19	
61	RB	12¼	9982	9990	8	5½	1.45	
62	RB	12¼	9990	9996	6	4½	1.33	
63	RB	12¼	9996	10003	7	4½	1.56	
64	RB	12¼	10003	10010	7	3½	2.00	
65	RB	12¼	10010	10020	10	6	1.67	
66	RB	12¼	10020	10029	9	4	2.25	
67	RB	12¼	10029	10074	45	9½	4.74	
68	RB	12¼	10074	10111	37	8½	4.35	
69	RB	12¼	10111	10161	50	9	5.56	
70	RB	12¼	10161	10243	82	9½	8.63	
71	RB	12¼	10243	10306	63	9½	6.63	
72	RB	12¼	10306	10329	23	10	2.30	
73	RB	12¼	10329	10342	13	7	1.86	
74	RB	12¼	10342	10348	6	6½	.96	
75	RB	12¼	10348	10365	17	6½	2.62	
76	RB	12¼	10365	10397	32	10	3.20	
77	RB	12¼	10397	10423	26	9½	2.74	
78	RB	12¼	10423	10439	16	6¾	2.37	
79	RB	12¼	10439	10458	19	8½	2.24	
80	RB	12¼	10458	10469	11	6	1.83	
81	RB	12¼	10469	10499	30	8	3.75	
82	RB	12¼	10499	10546	47	13¼	3.55	
83	RB	12¼	10546	10559	13	7	1.86	
84	RB	12¼	10559	10597	38	12½	3.04	
85	RB	12¼	10597	10631	34	11½	2.96	
86	RB	12¼	10631	10654	23	9½	2.42	
87	RB	12¼	10654	10673	19	10½	1.81	
88	RB	12¼	10673	10694	21	10	2.10	
89	RB	12¼	10694	10718	24	10½	2.29	
90	RB	12¼	10718	10738	20	10½	1.90	
91	RB	12¼	10738	10754	16	9	1.78	
92	RB	12¼	10754	10772	18	9	2.00	
93	RB	12¼	10772	10796	24	9½	2.53	
94	RB	12¼	10796	10824	28	8½	3.29	
95	RB	12¼	10824	10846	22	9¼	2.38	
96	RB	12¼	10846	10882	36	9	4.00	
97	RB	12¼	10882	10905	23	9½	2.42	
98	RB	12¼	10905	10928	23	10	2.30	
99	RB	12¼	10928	10947	19	7	2.71	
100	RM	12¼	9119	10947	Reaming			
101	RM	12¼	7900	8636	Reaming			
102	RM	12¼	8636	10947	Reaming			
103	RB	8⅜	10947	10950	3	3	1.00	

Table continued on next page

CONGRATULATIONS

OHIO OIL CO.

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Another Milestone in Drilling Progress

20,927 ft.

Schlumberger is Proud to Have

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SCHLUMBERGER WELL SURVEYING CORPORATION

TABLE 1. Continued from last page.

Abbreviations: RB — Rock bit. C — Core-head. RM — Reamer. DB — Diamond bit. DC — Diamond core-head. R — Rereaming. S — Sidetracking. CO — Cleaning out.

Bit number	Type bit	Size	Depth on	Depth off	Total feet	Hours	Av. ft.	Explanation
104	RB	8⅜	10950	10955	5	5	1.00	
1	DB	8¼	10955	10956	1	3	.33	
2	DB	8¼	10956	10957	1	5	.20	
105	RB	8⅜	10957	10970	13	8	1.63	
106	RB	8⅜	10970	10979	9	8	1.13	
107	RB	8⅜	10979	10986	7	7½	.93	
108	RB	8⅜	10986	10993	7	9	.78	
3	DB	8¼	10993	11099	106	113		
1	DC	8¼	11099	11128	29	25½		
3	R-DB	8¼	11128	11223	95	116½	.88	Compl. 201′–229½ hours.
4	DB	8¼	11223	11280	57	71		
1	R-DC	8¼	11280	11306	26	26½		
4	R-DB	8¼	11306	11334	28	39½		
5	DB	8¼	11334	11415	81	93	.87	
4	R-DB	8¼	11415	11538	123	82½		
1	R-DC	8¼	11538	11596	58	20½		
4	R-DB	8¼	11596	12020	424	214	1.55	Compl. 632′–407 hours.
6	DB	8¼	12020	12274	254	126		
1	R-DC	8¼	12274	12288	14	17½		
7	DB	8¼	12288	12444	156	129½		
8	DB	8¼	12444	12947	503	386½		
109	RB	8¼	12947	12952	5	3½	1.43	
8	R-DB	8¼	12952	13011	59	67	1.24	Compl. 562′–453½ hours.
9	DB	8¼	13011	13160	149	170¼		
10	DB	8¼	13160	13431	271	198¼		
11	DB	8¼	13431	13497	66	50¾		
1	R-DB	8¼	13497	13531	34	18		
11	R-DB	8¼	13531	13670	139	148¾		
1	R-DC	8¼	13670	13685	15	17		
11	R-DB	8¼	13685	13768	83	110¾	.93	Compl. 288′–310¼ hours.
12	DB	8¼	13768	13818	50	58½		
110	RB	8¼	13818	13832	14	11	1.27	
12	R-DB	8¼	13832	13877	45	55½	.83	Compl. 95′–114 hours.
1	R-DC	8¼	13877	13963	86	69½		
111	RB	8¼	13963	13792	9	10½	.86	
1	R-DC	8¼	13972	13990	18	24½		
112	RB	8¼	13990	13994	4	5½		
1	R-DC	8¼	13994	14861	867	639¾	1.34	Compl. 1147′–859 hours.
13	DB	8¼	14861	14947	86	95		
2	DC	8¼	14947	14974	27	35½		
113	RB	8¼	14974	14986	12	7½	1.60	
2	R-DC	8¼	14986	15723	737	747	.98	Compl. 764′–782½ hours.
13	R-DB	8¼	15723	15765	42	55		
3	DC	8¼	15765	15794	29	45½		
4	DC	8¼	15794	15848	54	65½		
3	R-DC	8¼	15848	15902	54	48		
4	R-DC	8¼	15902	15956	54	27½		
3	R-DC	8¼	15956	16010	54	36½		
4	R-DC	8¼	16010	16061	51	54½		
3	R-DC	8¼	16061	16115	54	39¼		
4	R-DC	8¼	16115	16169	54	42		
3	R-DC	8¼	16169	16223	54	30½		
4	R-DC	8¼	16223	16227	54	41½		
3	R-DC	8¼	16277	16331	54	28¾		
112	R-DB	8¼	16331	16333	2	1	.92	Compl. 6′–6½ hours.
4	R-DC	8¼	16333	16387	54	30¼		
3	R-DC	8¼	16387	16441	54	27	1.38	Compl. 353′–255½ hours.
4	R-DC	8¼	16441	16495	54	30	1.29	Compl. 375′–291¼ hours.
5	S-DC	8¼	16426	16460	34	24		
114	CO-RB	7⅞	16460	16460	0	—		
6	DC	8¼	16460	16460	0	—		Outer core barrel broke off.
7	DC	8¼	16460	16537	77	34¾		
8	DC	8¼	16537	16621	84	38		
7	R-DC	8¼	16621	16650	29	14		
8	R-DC	8¼	16650	16678	28	14½		
7	R-DC	8¼	16678	16706	28	13½		
8	R-DC	8¼	16706	16734	28	14		
7	R-DC	8¼	16734	16760	26	15		
8	R-DC	8¼	16760	16818	58	30		
13	R-DB	8¼	16818	16876	58	41½	.97	Compl. 186′–191½ hours.
7	R-DC	8¼	16876	16934	58	21½		
8	R-DC	8¼	16934	16990	56	29¼		
7	R-DC	8¼	16990	17046	56	26		
8	R-DC	8¼	17046	17102	56	26½		
7	R-DC	8¼	17102	17136	34	26	2.04	Compl. 308′–150¾ hours.
9	DC	8¼	17136	17192	56	61½		
10	DC	8¼	17192	17248	56	48¾		
9	R-DC	8¼	17248	17304	56	40		
115	Hard Metal Special Drlg. Bit	8¼	17304	17308	4	8	.50	
10	R-DC	8¼	17308	17364	56	36¾		
9	R-DC	8¼	17364	17392	28	28¼		
10	R-DC	8¼	17392	17448	56	53		
9	R-DC	8¼	17448	17487	39	47¼		
10	R-DC	8¼	17487	17523	36	32¼		
9	R-DC	8¼	17523	17540	17	19¼		
10	R-DC	8¼	17540	17553	13	22½		
9	R-DC	8¼	17553	17566	13	19		
8	R-DC	8¼	17566	17575	9	15½		
10	R-DC	8¼	17575	17601	26	37½		
9	R-DC	8¼	17601	17612	11	22		
14	DB	8¼	17612	17761	149	158¾	.94	
10	R-DC	8¼	17761	17777	16	21¼		
9	R-DC	8¼	17777	17802	25	31¾		
10	R-DC	8¼	17802	17838	36	52¼		
15	DB	8¼	17838	17926	88	92¾	.95	
10	R-DC	8¼	17926	18038	112	106		
9	R-DC	8¼	18038	18094	56	48¼		
10	R-DC	8¼	18094	18150	56	48		
9	R-DC	8¼	18150	18206	56	53		
16	DB	8¼	18206	18286	80	110½		
9	R-DC	8¼	18286	18342	56	68¾	.72	
16	R-DC	8¼	18342	18445	103	123¼	.78	Compl. 183′–233¾ hours.
10	R-DC	8¼	18445	18501	56	53¼		

Table continued on next page

reached record depth without the use of oil base mud—considering the hard packed shales and the almost continuous coring with diamond core heads and drilling with diamond bits from 10,955 ft.

It is believed that oil base mud reduced fishing jobs to a minimum. Another factor—the lower viscosity of oil base mud—made it unnecessary to maintain abnormally high pump pressures. For example, at 20,000 ft, Ohio's deep test was still able to break circulation of the mud with pump pressures of 800 psi, and while drilling at this depth, pump pressures beyond 1700 psi were not needed.

Following the changing to oil base mud at 10,955 ft, 8⅜-in. hole was carried to 10,994 ft and from that depth an 8¼-in. hole has been either drilled or cored.

Initially the oil base mud was weighted to 85 lb per cubic foot. At 13,818 ft, the bit drilled into a salt water flow of 7 to 21 bbl per hour. Mud weight was increased to 125 lb per cubic foot, which killed the flow. However, the formation began taking the mud and it was necessary to reduce the weight to 115 lb. Now a constant watch must be kept on the mud. If the weight drops below 115 lb, salt water will come in to contaminate the mud system. If the weight goes above 118 lb, mud starts going into the formation.

Considering its depth, the Paloma project has been relatively free of mechanical difficulties. It has had only two fishing jobs, a minor one when drill pipe was stuck at 10,957 ft, and a major one when core barrel and core head were stuck at 16,495 ft.

While reaming the hole preparatory to running the 9⅝-in. casing, drill pipe was stuck at 7872 ft. Pipe was backed off one joint above the drill-collars. After going back in with socket and jars, and unsuccessfully jarring on the fish, cutters were run and a 15-ft cut made on the 5 9/16-in. drill pipe.

A pack-off socket was run, and after unsuccessful attempts to spot oil around the remaining fish, or to back off the drill collars above the bit with the aid of string shots, the fish was recovered by first washing over with 9⅝-in. washpipe and an 11¾-in. wash-over shoe, and then fishing with socket and jars. Time spent fishing was 13 days.

The major fishing job occurred at a depth of 16,495 ft. A complete 54-ft core had been taken and the driller was preparing to come out of the hole when it developed that the pipe was stuck.

Full circulation was maintained. Jarring was started with 15-ton blows then gradually increased to 50-ton blows over a period of 4 days, with actual jarring time being 40 hours. As a safety precaution, the drilling line was moved slightly every three hours while jarring. When this program failed, the drill pipe and drill collars were backed off above the core barrel and attempts to sidetrack the fish began.

After several attempts, The Ohio project finally succeeded in sidetrack-

XUM

The world's deepest well was drilled with Black Magic

Two of the three deepest wells in the world were drilled with Black Magic. At 10,955′ in Ohio Oil's record-breaking well at Paloma. Black Magic replaced the clay water mud and was used from that point to the world's new record. On September 1, 1953, the well was drilling below 20,650′. At no time was any trouble encountered which could be attributed to the mud. From Ohio Oil's report, "... use of the oil base mud is believed to have reduced fishing jobs to a minimum." Black Magic was unaffected by the high temperature (Bottom Hole temperature at 20,003′ was 334°F).

The low viscosity of Black Magic permitted lower pump pressure. "At 20,000′ the Ohio Oil Company's deep test was still able to break circulation of the mud with pump pressures of 800 p.s.i. and while drilling at this depth pump pressures were not needed beyond 1,700 p.s.i." Black Magic was weighted to 85 lbs./cu. ft. (11.3#/gal.) at the start but increased to 125 (16.7#/gal.) to kill a salt water flow. Maintenance time was negligible and cost extremely low despite the high flow line temperature which reached 175°F. Accurate electric and radiation logs were obtained at 20,003′. For deep well drilling, switch to Black Magic. Contact your Oil Base representative for details.

OIL BASE, Inc. 130 ORIS STREET, COMPTON, CALIFORNIA

Bakersfield, Long Beach, Ventura, Newhall, Houston, Fort Worth, Oklahoma City, Midland, Odessa, Jennings, Caracas, Paris

XUM

TABLE 1. Continued from last page.

Abbreviations: RB — Rock bit. C — Core-head. RM — Reamer. DB — Diamond bit. DC — Diamond core-head
R — Rereaming. S — Sidetracking. CO — Cleaning out.

Bit number	Type bit	Size	Depth on	Depth off	Total feet	Hours	Av. ft.	Explanation
9	R-DC	8¼	18501	18557	56	48½		
10	R-DC	8¼	18557	18613	56	42½		
9	R-DC	8¼	18613	18669	56	39¼		
10	R-DC	8¼	18669	18725	56	33¾		
9	R-DC	8¼	18725	18781	56	31¾		
10	R-DC	8¼	18781	18837	56	43¼	1.09	Compl. 687'–631 hours.
9	R-DC	8¼	18837	18866	29	31		
8	R-DC	8¼	18866	18889	23	28½		
17	DB	8¼	18889	19049	160	96¼	1.66	
9	R-DC	8¼	19049	19105	56	45	1.05	Compl. 666'–634¼ hours.
8	R-DC	8¼	19105	19161	56	43¼		
11	DC	8¼	19161	19189	28	41		
12	DC	8¼	19189	19245	56	44½		
11	R-DC	8¼	19245	19301	56	42½		
18	DB	8¼	19301	19390	89	74¼	1.20	
12	R-DC	8¼	19390	19417	27	28		
11	R-DC	8¼	19417	19473	56	47		
12	R-DC	8¼	19473	19491	18	23		
19	DH	8¼	19491	19686	195	168	1.16	
11	R-DC	8¼	19686	19742	56	54	1.04	Compl. 196'–184½ hours.
12	R-DC	8¼	19742	19798	56	63	.99	Compl. 157'–158½ hours.
20	DB	8¼	19798	20003	205	154½	1.33	
8	R-DC	8¼	20003	20035	32	26	1.23	Compl. 430'–265½ hours.
20	R-DB	8¼	20035	20133	98	82½	1.19	Compl. 303'–237 hours.
21	DB	8¼	20133	20323	190	182½	1.04	
22	DB	8¼	20323	20529	206	167	1.23	

ing the fish. Total elapsed time from sticking of the core barrel to regaining previous depth of 16,495 ft was 54 days.

In addition to the core and rate of penetration logs, seven other logs have been made to aid in evaluating the formations encountered.

Logs were run as follows:

1. Conventional electric resistivity and natural potential logs 1430 ft to 10,947 ft (in clay mud system)
2. Mono-electrode resistivity and natural potential log 10,947 ft to 16,737 ft (in oil bas mud system)
3. Gamma ray radioactivity log 8000 ft to 17,732 ft (in oil base mud system)
4. Induction log 10,947 ft to 20,003 ft (in oil base mud system)
5. Gamma radiation log 11,000 ft to 20,003 ft (in oil base mud system)
6. Neutron radiation log 11,000 ft to 20,003 ft (in oil base mud system)
7. Scratcher resistivity and natural potential log 10,947 ft to 19,049 ft (in oil base mud system)

The Ohio Oil Company spudded its deep test well in recent alluvium and drilled in this horizon to an approximate depth of 1000 ft. From approximately 1000 ft to 4200 ft the well was in Tulare sands and clays of Pleistocene age. From 4200 ft to 5700 ft the well made hole through San Joaquin clays and sands, including the Paloma-Buena Vista gas field producing sands, of Pliocene age. From 5700 ft to 8800 ft the well was in Etchegoin sands and claystones of Pliocene age. From 8800 ft to 13,800 ft the hole was in Antelope-Stevens shale and sands of Miocene age. From 13,800 ft to record depth the well was in Temblor-Vaqueros sands and shale of Miocene age.

Approximately 49 per cent of the Miocene section is sand.

The Ohio Oil Company plans to run a string of 5½-in., P-105, 26-lb special Extremeline, 23-lb special Extremeline, and 20-lb regular Extremeline to test the well.

This P-105-grade pipe is a heat-treated N-80 to increase the minimum yield to 105,000 usi and test samples were run on the actual pipe showing the minimum properties in excess of the calculated properties. According to present plans, after the 5½-in. casing is cemented in the deep hole, selected intervals will be perforated and tested.

The Ohio Oil Company has set cost of operating the big rotary at Paloma from $1600 to $2000 per day. By the time the project is completed, the company will have spent over $1,300,000 on the deep test.

Men who have played an important part in the drilling of the well include the following:

John B. Sutherland, assistant to the general manager of production; George Sowards, division manager; Robert M. Miller, assistant Los Angeles division manager; W. T. Kennedy, division production superintendent, recently transferred to division headquarters at Los Angeles; B. H. Doan, drilling superintendent; R. L. Durham, E. L. Fletcher and J. C. Weaver, rotary drilling foremen; A. F. Tokash, district production superintendent; R. W. Shoemaker, district geologist; Tom Wilson, geologist who "sat on" the well; W. B. Emery, II, district petroleum engineer; C. W. Stephens, division petroleum engineer; Don Everitts, Frank Rieber, W. C. Sheldon and other petroleum engineers; and former Division Geologist Glen Gariepy, who was recently transferred to The Ohio Oil Company's Shreveport production division as assistant division manager.

The late Ben Hollandsworth of Bakersfield, former drilling superintendent for Ohio Oil Company, also had considerable responsibility in the drilling of the well.

Drilling crews were as follows:

V. E. "Bill" Gillett, driller; J. J. Helton, derrickman; Leroy Finley, A. McKay and W. E. McLaughlin, rotary helpers.

W. T. White, driller; C. A. Craig, derrickman; Roy Baxter, Otis Roberson and V. R. Poehner, rotary helpers.

Frank Sherman, driller; H. L. Patkoski, derrickman; B. L. Calhoun, D. F. Young and Carl Mead, rotary helpers.

Fred Ryan, driller; N. C. Tuttle, derrickman; N. S. Woodside, D. O. Shrader, and J. B. Thorp, rotary helpers.

Others included W. A. Harris, relief driller; S. R. Norton, vacation relief man; H. Tudor, daylight extra man; and Ivan G. Seanor, mechanic.

DRILLING superintendent B. H. "Curly" Doan, congratulates driller Frank Sherman shortly after world's depth record was broken. Sherman was at brake when record fell.

In addition to the usual hazards of drilling a deep well, The Ohio Oil Company's Paloma project was faced with an unexpected situation at 4:52 a.m. on July 21, 1952, when the Tehachapi earthquake occurred. The well is situated only 14 miles northwest of the epicenter of the severe earthquake.

Driller Fred Ryan, with 30 years' rotary experience in California fields, 20 of them with The Ohio Oil Company, was at the controls when the quake hit. The well was drilling with bit on bottom making hole at 14,310 ft.

Thrown from side to side, Ryan kept hold of the brake on the drawworks, then got the brake chained down after the first heavy termors. Had Ryan let go of the brake, the five ton block and one ton hook would have crashed to the derrick floor and conceivably have terminated the Paloma project.

Crew members might have been killed, equipment damaged, and drill pipe jammed down the hole and stuck. A serious fishing job could have resulted with possible loss of the deep hole and abandonment at the 14,310 ft depth.

Ryan and his crew reported the derrick swayed with its top making an arc from 15 to 20 ft. The swaying of the derrick during the earth tremors was so great that the drilling lines supporting the heavy block, hook and drill pipe slapped the sides of the derrick.

Fortunately the well came through unscathed and continued on its way with the deep prospecting work which carried it past the world's former depth record. * * *

TYPE "PRZ" PRESSURE PACKER

the more pressure you apply the tighter it gets

SAFE to run
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POSITIVE removal

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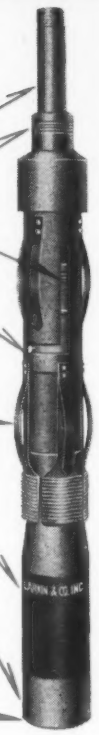
Flood water injection.

Gas injection.

Salt water disposal.

Isolating casing leaks (both injection and pumping wells).



Full 2", 2½", or 3" opening through entire length of tool. Can pump from below packer. Easily cement lined.

Standard Fishing Neck

Standard Fishing Neck

Corrosion free manganese bronze J pin

Springs holding slips in compression which forces them away from casing when tool is released.

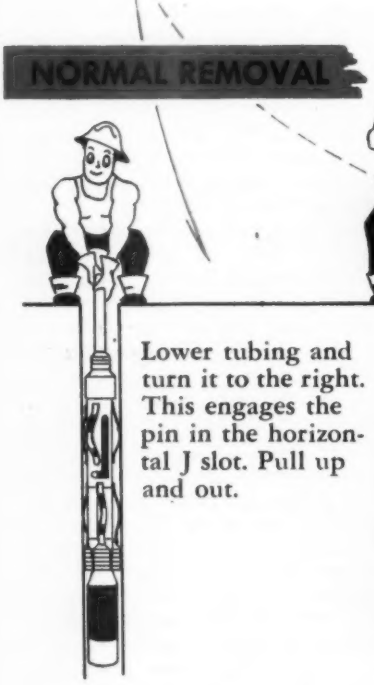
Oil Resistant Packing Element

Corrosion free cast iron bottom.

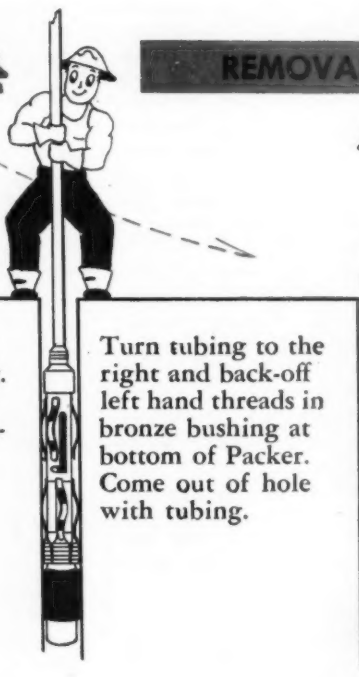
Corrosion free manganese bronze insert which has bottom tail pipe connection and upper left hand back-off thread for tubing mandrel.

C-104

NORMAL REMOVAL

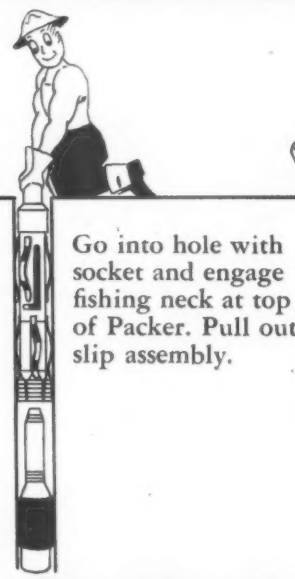


Lower tubing and turn it to the right. This engages the pin in the horizontal J slot. Pull up and out.



Turn tubing to the right and back-off left hand threads in bronze bushing at bottom of Packer. Come out of hole with tubing.

REMOVAL IF STUCK AFTER YEARS IN HOLE



Go into hole with socket and engage fishing neck at top of Packer. Pull out slip assembly.

Go back into hole with socket and engage second fishing neck. Pull out remainder of Packer.

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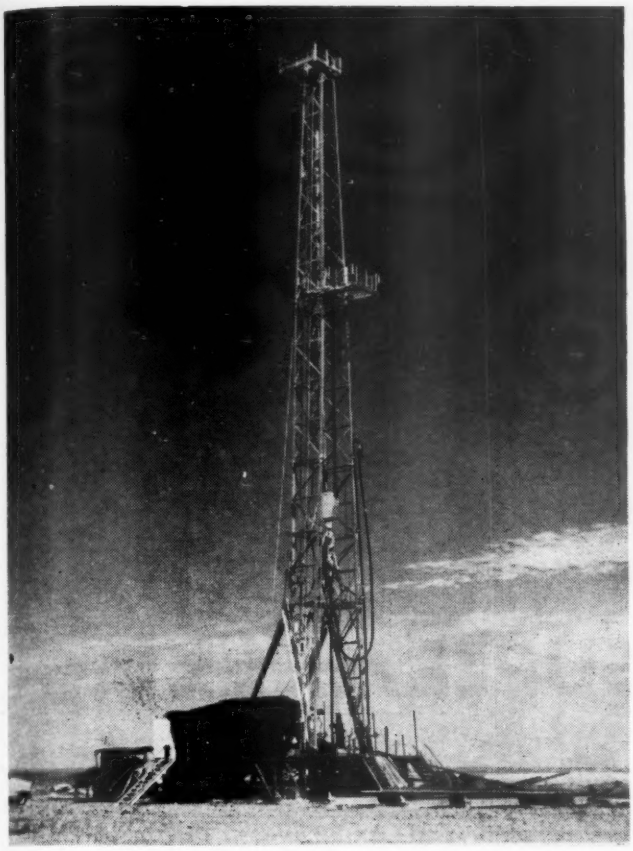
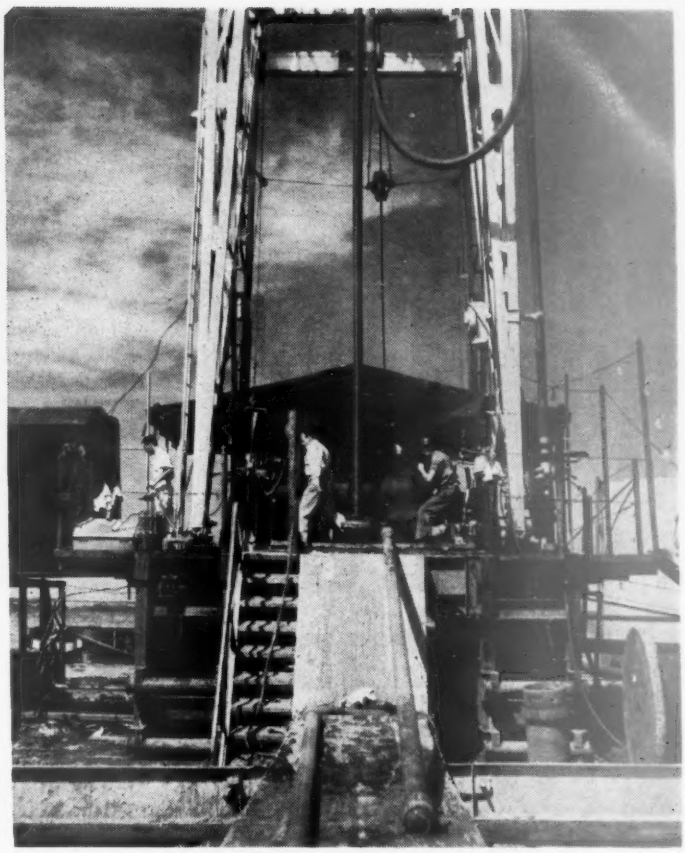


DENVER BASIN rig in operation near Sidney, Nebraska.



CLOSEUP showing drilling platform of No. 1 Schnell.

Mud Control Aids Nebraska Discovery

Study of core analysis made on nearby unsuccessful test provides basic drilling data

P. A. and H. V. KNUPP

THE Ryan Oil Company's No. 1 Schnell, a wildcat in Cheyenne County, Nebraska, was completed as a discovery well in the "D" sand of Cretaceous age on July 30, 1953. Initial production was 100 bbl of oil per day. This well is slightly east of the established NE-SW primary producing trend of the Denver Basin.

The No. 1 Schnell was drilled after study of the core analysis of a previous well drilled near this location that did not have a favorable drillstem test and was subsequently plugged and abandoned. Careful attention therefore was given to the mud program, and to coring and testing techniques. A high viscosity-low water loss mud was used in lieu of an oil emulsion system. The maximum water loss in exposed sand was 5½ cc's. The first core was cut to a point estimated to lie immediately above the oil water contact and the ensuing test proved successful.

The S. D. Johnson Drilling Company of Wichita Falls and Denver moved in its Lee Seymour 120-ft derrick with jackknife mast, capable of drilling to 8500 ft, on May 8, 1953. It had a Wilson Streamlined Giant Roadair drawworks and a Gardner-Denver 7¼-in. by 14-in. pump. Drilling superintendent was Mike Baird. Geology on the well was by H. Trueblood, Jr., of Denver. Overall management was under the direction of Jerry Ryan of Ryan Oil Company.

The well was spudded and 235 ft drilled through surface sand and shale. Five joints of 10¾-in. casing were set at 219 ft and cemented to surface with 200 sacks of cement. Drilling continued, and mud was inaugurated at 4100 ft.

EXCLUSIVE

At 4365 ft the rig circulated and conditioned the mud for coring. A Drilling and Service Company core bit and barrel cut core No. 1 from 4365 to 4398 ft with full recovery. Two zones of sand had favorable shows. The first drillstem test with 7¾-in. and 5-in. packers did not reach bottom. The rat hole was conditioned and the second drillstem test was successful. Two 5½-in. packers were set at 4370.5 and 4380.5 ft, and the interval between 4380 and 4398 ft was tested. The tool was open 2 hr and shut in 20 min. The tool opened with a very strong blow decreasing to a good blow after 25 min. Gas was recorded at the surface in 32 min. A good blow continued until the end of the test; 2124 ft of 33 API gravity oil was recovered

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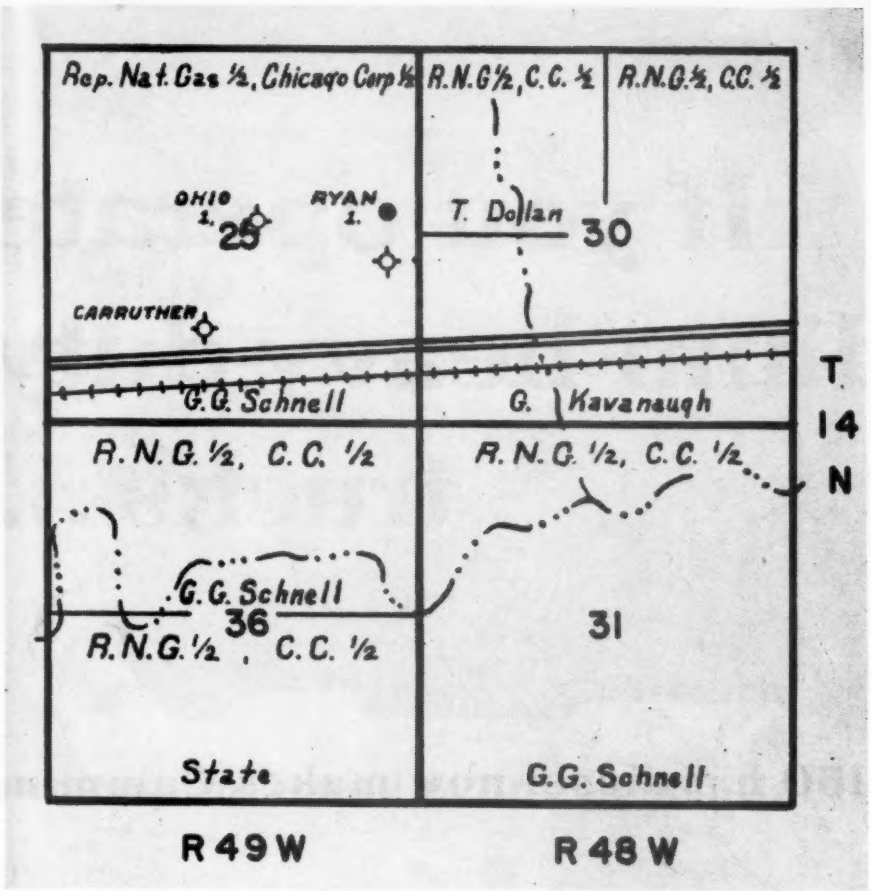


Cheyenne County, Nebraska.

20-min shut in bottom hole pressure was 1125 psi.

Drilling was continued to 4440 ft total depth. Schlumberger electric survey and microlog were run to a total depth of 4437 ft. The formation tops were:

	Surface, ft	Datum, ft
Niobrara	3598	—409
Fort Hays	3903	—104
Codell	3953	—54
Carlisle	3970	—37
Greenhorn	4130	—123
Bentonite	4272	—265
"D" sand	4373	—366
"G" sand	4433	—426

J55 casing, 5½-in., 15.5 lb, was run to 4437 ft and cemented with 300 sacks cement. The zone 4390-99 was perforated with 72 shots and the zone 4373-75 ft with 16 shots; 165 bbl of oil were swabbed in 12 hr. Upon further testing 12 bbl of oil per hour were swabbed through 2-in. tubing, then 7-9 bbl of oil per hour, and 125 bbl of oil per day.

As drilling in the Denver Basin comes

Core record for Schnell No. 1.

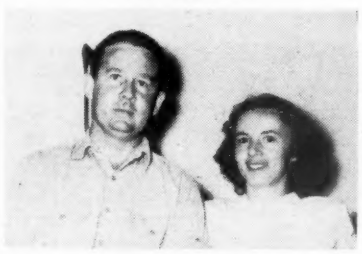
Core No. 1 — 4365–4398 ft
Recovered — 33 ft

Recovered
8 ft — Shale, black.
1 ft 3 in. — Sand, v.f. to f. gr., vertical fracture, good odor, stain, and fluorescence, porous and permeable.
2 ft 3 in. — Siltstone, very shaly (slightly carbonaceous) no show.
4 ft 10 in. — Siltstone, hard, dense, no show.
5 ft 4 in. — Shale, dark gray w/scattered silt inclusions, no show.
2 ft 3 in. — Sand, very silty, dirty, hard, tight, v.f.g., shaly, no show.
2 ft 4 in. — Sand, as above 2 ft 3 in., but had scattered sand breaks up to 3 in. thickness w/show of stain and fluorescence, weak odor, hard and tight.
6 ft 6 in. — Sand, v.f.g. to f. gr., silty, vertical fractures, porous and permeable, stain and pale yellow fluorescence somewhat spotty—odor ranged from fair to poor.

Core No. 2 — 4398–4418 ft
Recovered — 20 ft

Recovered
2 ft 3 in. — Sand, f.gr., porous, permeable, good stain, fair odor, pale yellow fluorescence, w/vertical fractures.
5 ft 9 in. — Siltstone, hard, tight, dense, very shaly, no show, grading to shale w/interbedded silt stringers.
6½ ft — Mudstone, hard, dense w/silt scattered throughout, no show.
1½ ft — Sand, grey, v.f.g., fairly tight, dirty, no stain, weak odor, no fluorescence (water).
1 ft — Sand, as above 1½ ft, but w/mudstone inclusions up to ½ in. thickness (water).
1 ft — Sand, v.f. to f.gr., porous, permeable, good stain, fair odor, pale yellow fluorescence (water?).
½ ft — Siltstone, gray, hard, tight, no show.
1½ ft — Sand, f.gr. to medium gr., highly broken and probably badly fractured, w/stain, fair odor, spotted pale yellow fluorescence, porous and permeable (water?).

The Authors



P. A. and H. V. Knupp were graduated from the University of Kansas with a BS in geology in 1948 and 1949, respectively. Both did post graduate work at the University until the fall of 1950. H. V. Knupp was employed by the British-American Oil Producing Company in Colorado as a field geologist while P. A. Knupp did subsurface work and mapping as a consultant in the Rocky Mountain area. Presently both are engaged in consulting work in Denver, Colorado.

and 90 ft of heavily oil cut mud. Initial flow pressure was 100 psi; the ½ hr flow pressure 500 psi; the 1 hr 600 psi, and the 2 hr 800 psi. The 20 min shut in bottom hole pressure was 1050 psi.

Preparatory to taking a second core, the rat hole was reamed and mud conditioned. Core No. 2 made full recovery from 4398 to 4418 ft; 2 ft 3 in. continuation of the second good sand zone was followed by shale and tight siltstone and then water saturated beds. For drillstem test No. 3, two 5½-in. packers were set at 4404 and 4411 ft. The interval tested was 4411 to 4418 ft. The tool was open 1 hr and 10 min and shut in 20 min. It opened with a good blow decreasing to fair by the end of 10 min. It decreased to a faint blow for 10 min and began increasing again to a fair blow. A fair blow continued throughout the rest of the test when the faint blow was recorded. Three stands of gas with a weak odor and 820 ft of brackish water with a scum of oil were recovered. The initial flow was at 0 psi; final flow 350 psi. The initial bottom hole pressure when the tool was plugged was 1050 psi. The

Core Analysis

Sample number	Depth, ft	Permeability, millidarcys		Porosity per cent	Liquid saturations, per cent pore space		Probable production
		Horizontal	Vertical		Water	Oil	
1	4373–74	39.6	0.3	15.0	35.1	11.7	Oil
2	4390–90½	4.3	0.0	17.8	33.1	9.0	Low perm.
3	4391½–92½	142.2	116.1	22.5	38.7	16.5	Oil
4	4392½–93½	159.0	73.2	21.9	36.5	17.1	Oil
5	4393½–94½	128.4	100.9	23.1	33.3	15.2	Oil
6	4394½–95	55.4	8.9	24.6	34.6	16.1	Oil
7	4395–96	364.0	65.8	22.5	44.4	17.8	Oil
8	4396–97	545.0	302.0	22.9	30.1	18.8	Oil
9	4397–98	524.0	269.8	22.2	22.5	16.7	Oil
10	4398–99	226.0	207.0	28.6	44.7	11.9	Oil
11	4399–4400	478.0	422.0	26.0	41.9	14.6	Oil
12	4412–13	16.1	0.0	21.2	72.0	0.0	Water (l.p.)
13	4413–14	5.2	0.1	20.7	74.4	4.1	Low Perm.
14	4414–15	11.1	0.0	21.0	68.0	0.0	Water (l.p.)
15	4415–16	650.0	510.0	19.7	40.6	16.8	Water
16	4416–17	900.0	10.0	23.9	45.2	19.2	Water
17	4417–18	1098.0	980.0	23.9	45.3	18.8	Water

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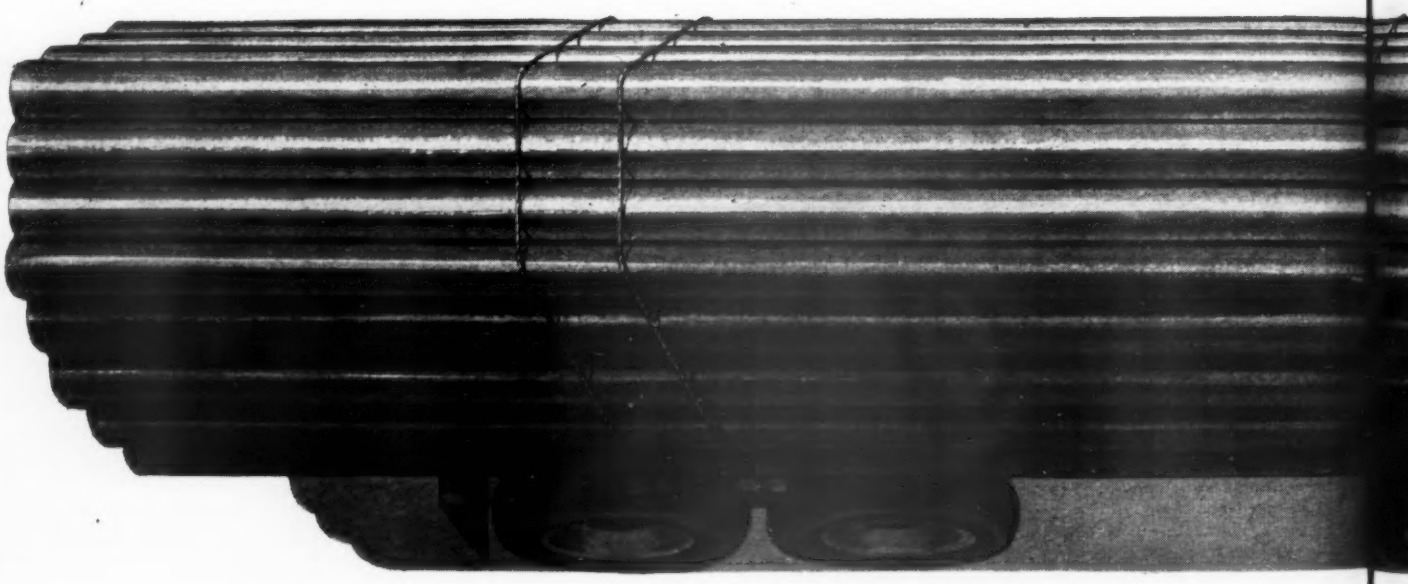

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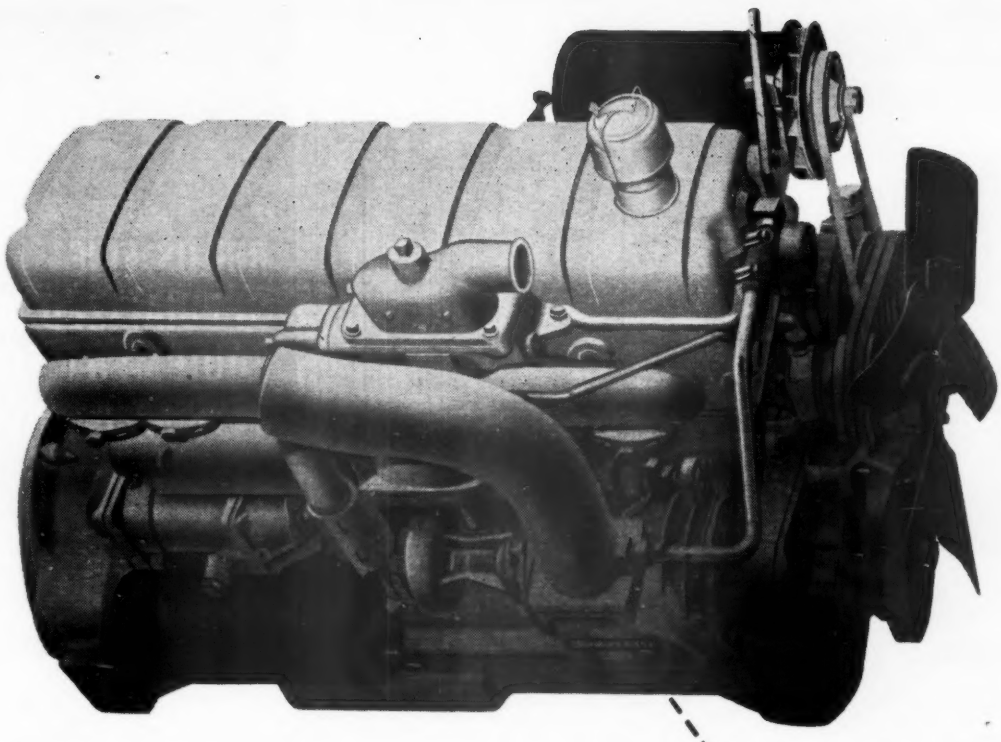
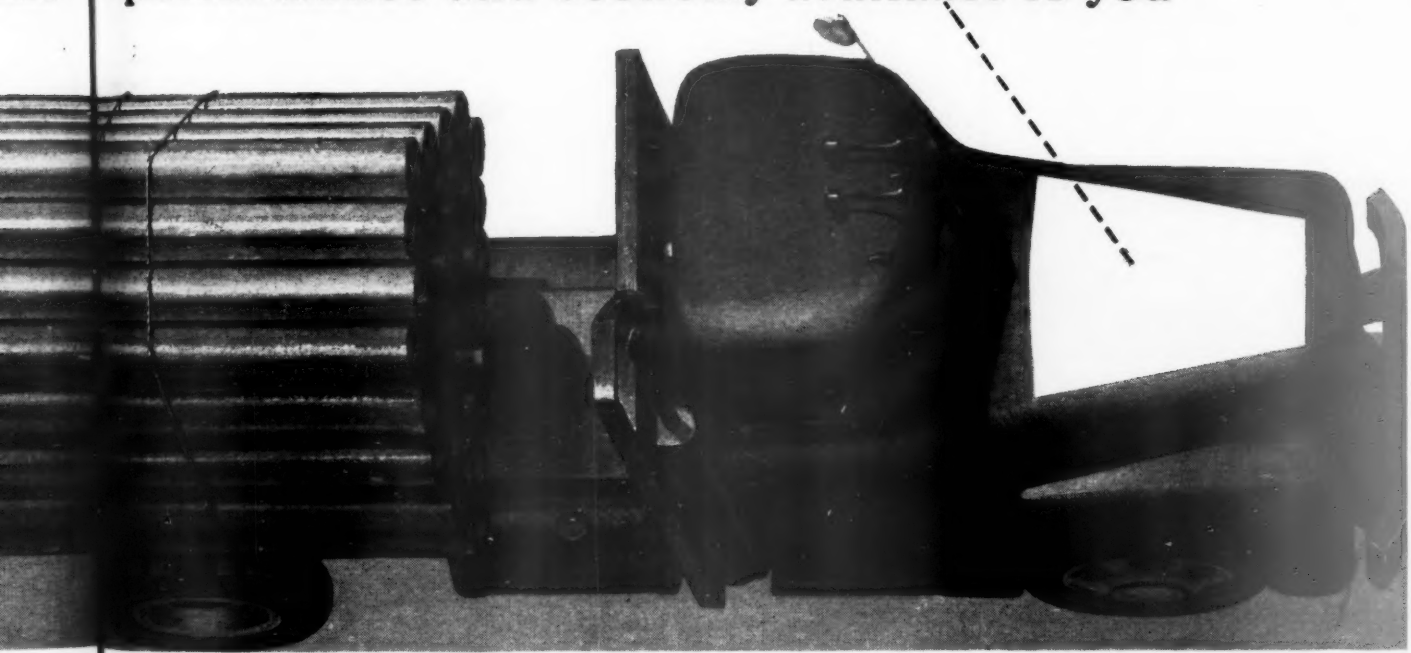


performance and economy available to you



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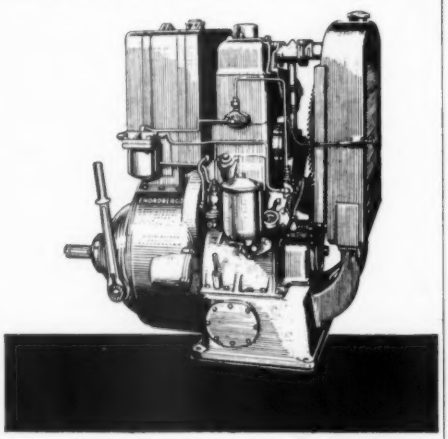

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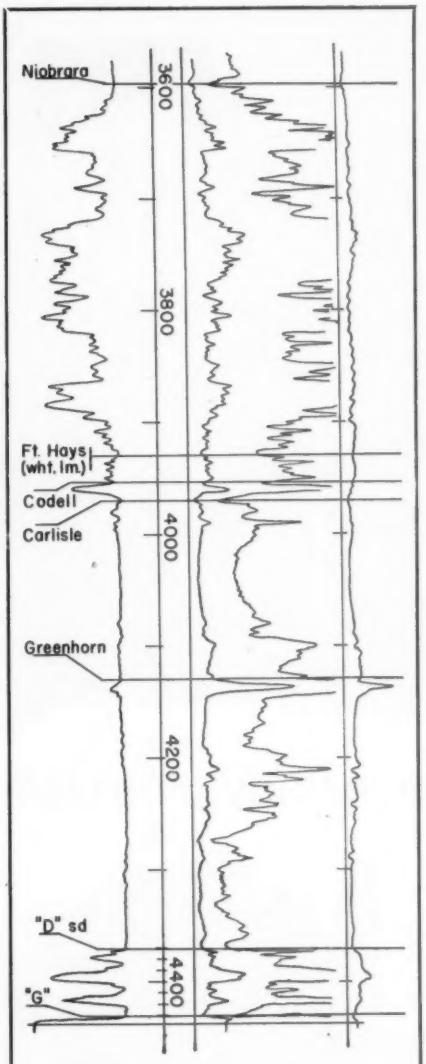

ELECTRIC LOG of Ryan No. 1 Schnell.

of age operators are beginning to pay increased attention to their mud program. In general, best results are obtained by use of a water based gel mud from 500 ft above the top of the Niobrara formation to total depth. Particular attention is given the condition of the mud just prior to cutting into the first sand. A high viscosity (60-70 sec) low water loss (5 cc's or less) mud should be maintained from this point to total depth. In some cases it is necessary to raise the viscosity to 100 sec or more in order to complete a drillstem test. The extra cost of a correct mud program is payed for many times by one commercial well that might have been plugged and abandoned. * * *

☆ ☆ ☆

A new National Oil Museum and Hall of Science has been chartered as a non-profit corporation to establish and maintain a museum in Tulsa, Oklahoma. Plans are that the museum will house working models of refineries, oil wells, pipe lines, and other apparatus showing oil industry operations. Petroleum memorabilia, educational exhibits, etc., are being sought.

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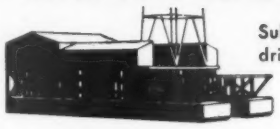

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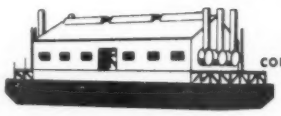

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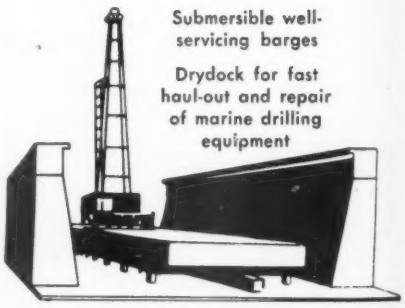

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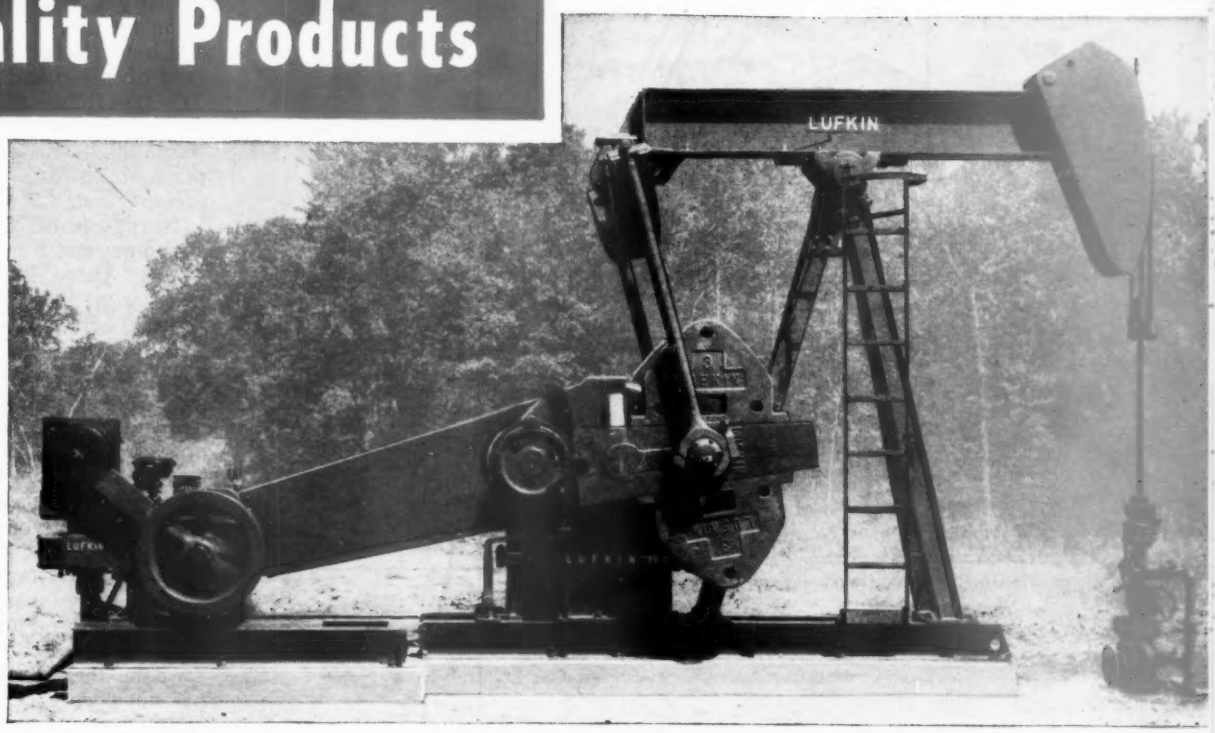

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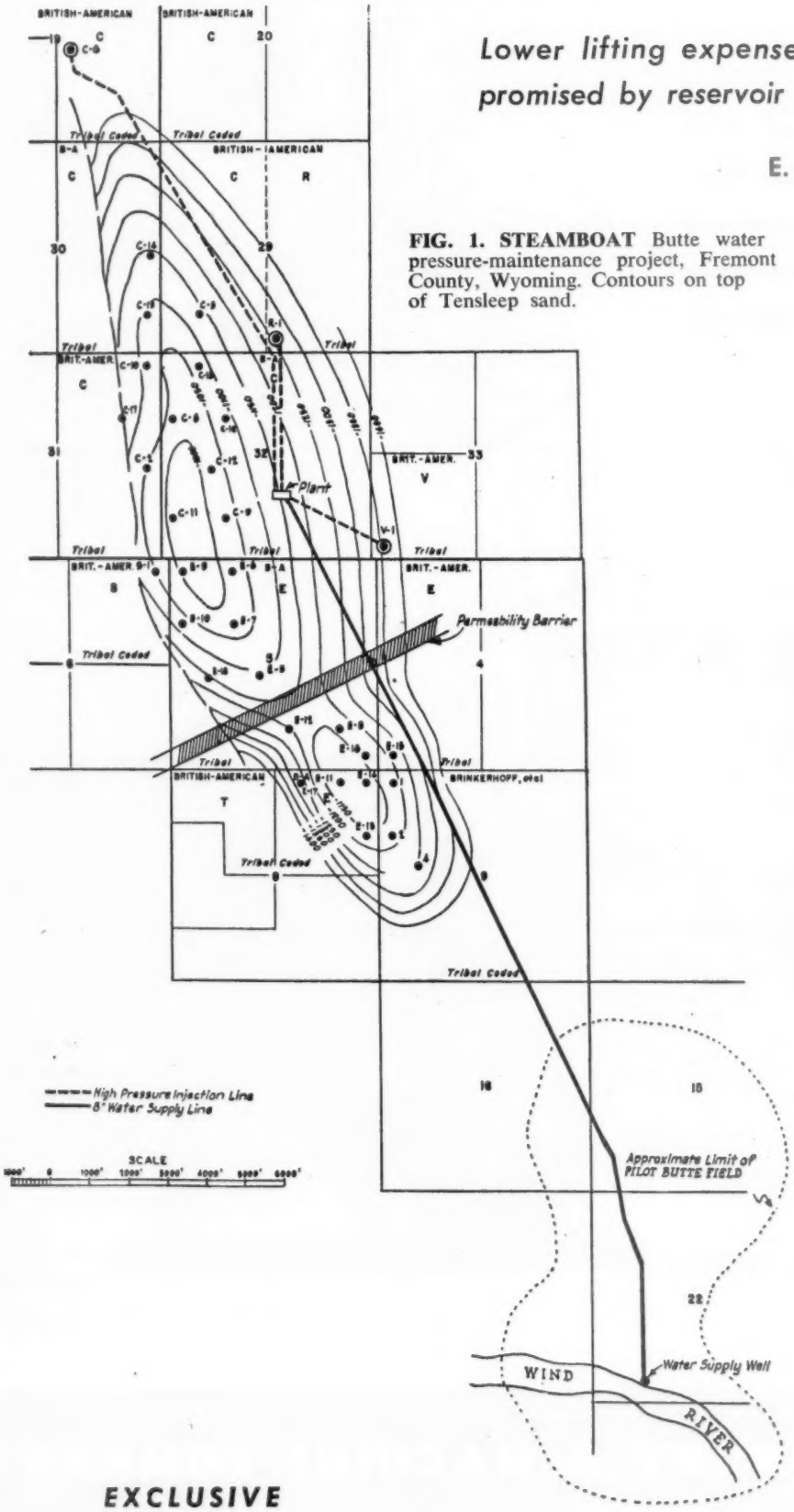

FIG. 1. STEAMBOAT Butte water pressure-maintenance project, Fremont County, Wyoming. Contours on top of Tensleep sand.

THE Steamboat Butte field is on the west flank of the Wind River Basin, a large structural basin about 150 miles long and 60 miles wide in Fremont County, Wyoming. The oil reservoir is a faulted asymmetrical anticlinal trap which is bounded on the west by a major fault, on the north and east by water at a subsea elevation of 1300 ft, and on the south by a fault or permeability barrier which lies somewhere between Tribal E-5 and Tribal E-12 Wells. (Fig. 1.)

Tribal C-2 (N.E. S.E. 31-4N-1W) was the discovery well in the Tensleep sand and was completed on March 11, 1944. This well initially was capable of pumping in excess of 1000 bbl of oil per day and had a draw down indicated capacity of 3300 bbl per day. The gravity of the oil is 29 - 30 deg API. Tribal C-2 had a penetration in the Tensleep sand of 263 ft and was completed at a TD 7034 ft (minus 1306 ft) with a reservoir pressure of 3000 psi. The initial solution gas-oil ratio was 125 cu ft per barrel and is less than 100 at the present time.

North Steamboat Butte Field now has nineteen Tensleep sand oil producers. There are 1135 productive acres with a net oil sand volume of 175,000 acre feet.

Purposes of the pressure maintenance project are (1), to permit a production rate compatible with market demand and (2), to avoid troublesome operating problems and high well operating costs caused by overloading presently installed pumping equipment.

Even though the daily water production is now only 1875 bbl, it was anticipated that the time would arrive when a very substantial part of the available natural water influx would be needed to replace the produced water. To date, the rate of water production has not been excessive because of the relatively high structural position and planned spacing pattern of the Tensleep producers.

The completion of the Platte Pipeline made it particularly desirable to put the pressure maintenance system into operation. The increased market demand would permit production of

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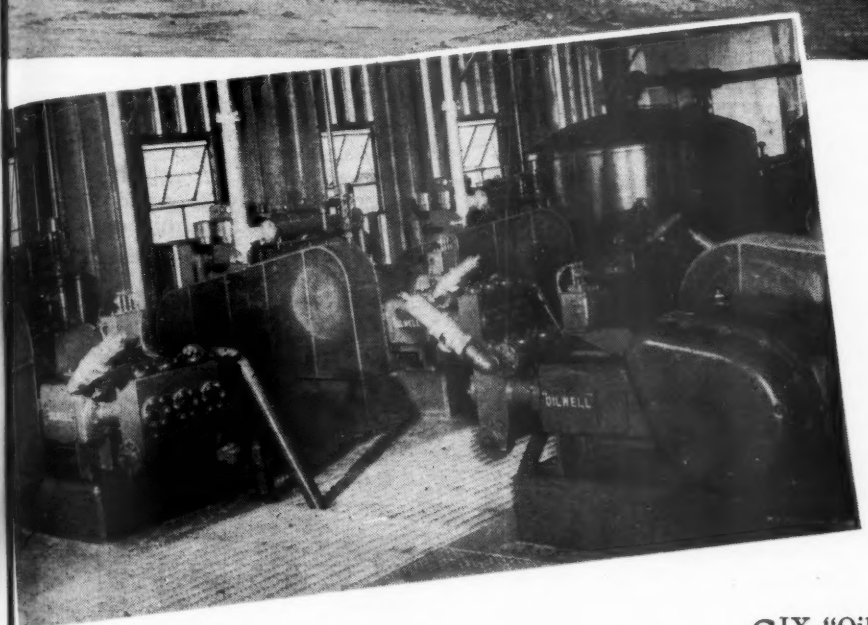

. . . for their NEW Pressure-Maintenance Plant at Steamboat Butte, Wyoming

SIX "Oilwell" 36-P Triplex Plunger Pumps were selected by B-A engineers for this project in the Steamboat Butte Field.

Three of the pumps are equipped with 2½" plungers, two 2¾", and one 3" to meet the different requirements of the various input wells.

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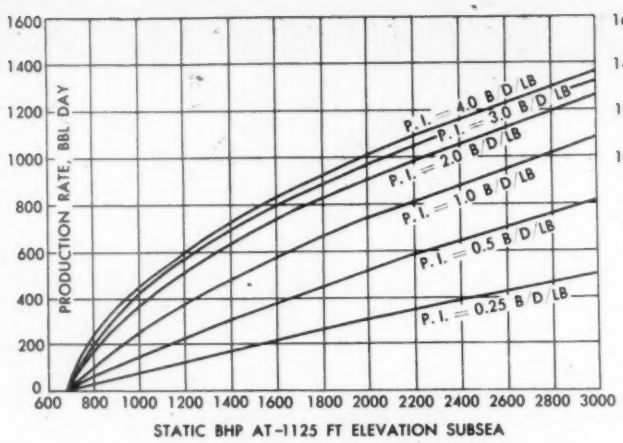
PRODUCTION RATE, BBL DAY
P. I. = 4.0 B D LB
P. I. = 3.0 B D LB
P. I. = 2.0 B D LB
P. I. = 1.0 B D LB
P. I. = 0.5 B D LB
P. I. = 0.25 B D LB
STATIC BHP AT -1125 FT ELEVATION SUBSEA

FIG. 2. PRODUCTION rate vs BHP for various P. I.'s at North Steamboat Butte (Oversize 2¼ in. standard valve).

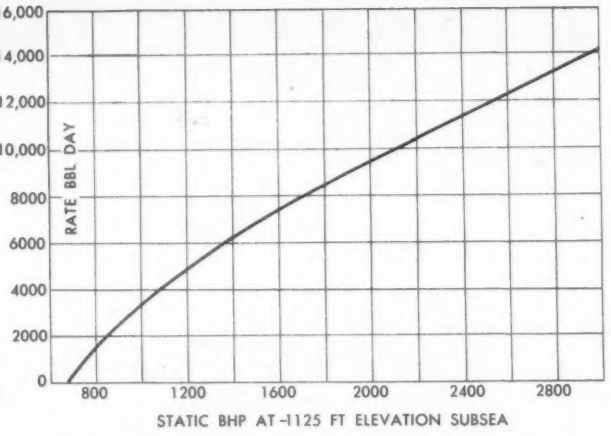

FIG. 3. RATE of production, composite, vs static BHP. Tensleep sand, North Steamboat Butte field.

The Author

E. W. Rogers is petroleum engineer in the general office of The British-American Oil Producing Company in Dallas, Texas. A graduate of Texas A&M College in June, 1949, with a BS degree in petroleum engineering, Rogers began his engineering career with British-American in their Southern district office, Houston, Texas. He was later transferred to the East Texas field where he obtained basic oil field experience as a roustabout. He was then transferred to the Gulf Coast of Texas for additional experience. His next assignment was as field engineer in the Steamboat Butte and Pilot Butte fields of Wyoming. In February, 1952, he was transferred to the general office. He acted as supervisor and expeditor of installation of the project described in the accompanying article.

the remaining reserves in a more reasonable length of time, but calculations of the future pressure behavior using the Hurst-van Everdingen method[1] showed that such future production rates would exceed the natural water influx at the prevailing reservoir pressure of 2500 psi. In turn, this demand would exceed the capacity of the installed surface pumping equipment if the pressures were allowed to drop. Three alternatives were evident: (1) maintain pressure by controlled water injection; (2) drill additional development wells to produce at the rate demanded by market, with a lower bottom hole pressure; (3) convert from the present beam-type to heavy hydraulic pumping equipment. It was concluded that alternative (1) was preferable.

[1] "Application of the La Place transformation to Flow Problems in Reservoirs" by Hurst and van Everdingen published in AIME Transactions, 1949, Vol. 186, paragraph 305.

In calculating the maximum rate of production from the Tensleep reservoir, the producing rate for each well for a known or estimated PI, as determined by field-wide fluid-level surveys, was read from Fig. 2 for different static bottom hole pressures. This chart is based on an empirical relationship between head of fluid in the casing and throughput capacity of the oversize standing valves now in use in the field. Fig. 3 was then prepared summarizing these data and showing rates of production vs static bottom hole pressure.

The Tensleep sand has reasonably continuous porosity and permeability over a large area. The thickness and lateral extent of the formation, the magnitude of its porosity and permeability, and the size and shape of the oil reservoir all have a direct bearing on the success of the pressure maintenance project. It is capable of receiving large quantities of water with small pressure differential. The water can migrate freely through the producing formation when this pressure differential exists, thus forcing the oil to migrate from one part of the reservoir to another. The direction of water movement will be from the north and east edges of the reservoir, toward the structurally higher portions of the field. The aquifer is very extensive and lies generally northeast of the field.

The average physical characteristics of the Tensleep sand reservoir and of the confined liquids are as follows: Permeability, 32 md; overall average porosity, 12 per cent; connate water, 11 per cent; viscosity of water, 0.5 cp; residual oil saturation, 19-32 per cent; viscosity of oil, 5.5 cp; bubble point, 392 psi; depth of producing zone, 6800 ft. Tensleep core analysis data on the wells in North Steamboat Butte field were correlated on top of the sand and combined into a composite permeability profile (Fig. 4). The core analysis data from the composite section were then grouped into five permeability groups with resulting weighted average values as shown in Table 1.

Reservoir study reveals that the Tensleep sand may be preferentially oil wet as indicated by imbibition and capillary pressure tests made at the University of Tulsa.

A study was made by Professor A. W. Walker and Robert Jaske, Tulsa University, on the evaluation of the

TABLE 1. Permeability groups and weighted average for composite Tensleep formation log.

Group	Permeability range, md,	Average permeability, md	Fraction of total samples	Weighted average permeability, md
1	Over 100	163	.089	14.5
2	50–100	66	.117	7.7
3	25–50	35	.151	5.3
4	10–25	17	.210	3.6
5	0–10	2	.433	0.9
			1.000	32.0

FIG. 4. PERMEABILITY profile of North Steamboat Butte Tensleep sand.

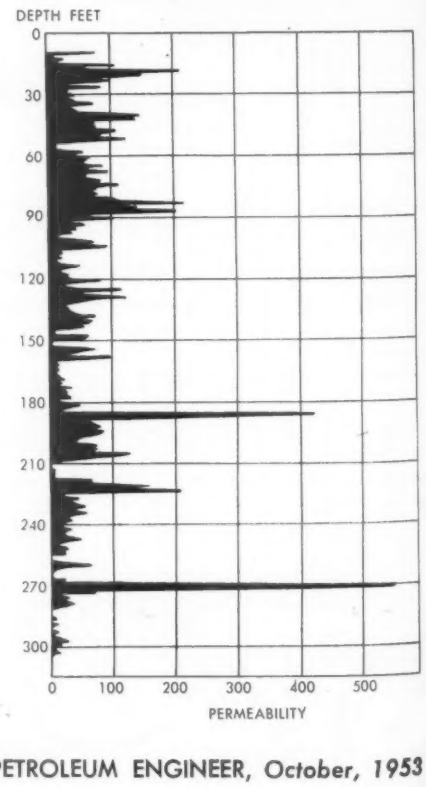

FIG. 5. **WATER** supply wells, Wind River Valley. **FIG. 6. WATER** supply well No. 1 (left, inset) Moturbo Peerless pump.

probable effects of a simulated natural water drive as compared to a gas-drive type mechanism. Their report concluded that the recovery by gas injection would correspond to the irreducible minimum saturation as determined from the gas-oil capillary pressure tests. Recovery by gas displacement is estimated to be approximately 40 percent of the pore volume and by water drive, to be approximately 70 per cent of the pore volume. This new wettability concept may have far reaching effects on the ultimate recovery, because it means a more favorable ratio between the permeability to oil of the clean oil producing section and the permeability to water of the wet section. It also means less connate water and a greater volume of oil in place, than would be expected under water-wet conditions.

It is anticipated that the total investment and operating costs under pressure maintenance will be significantly less than field investment and operating costs that would have been required without pressure maintenance.

Description of Water Injection System

Water Supply. It was not considered practical to return produced water to the reservoir because the produced water is not of sufficient volume to economically permit laying water-gathering lines. It is a simple process to allow the produced water, which is of very low salt content, to evaporate from properly managed pits. Furthermore, the produced water contains some hydrogen sulfide, and handling of such water would have required special measures for prevention of corrosion. Three supply wells were drilled 60 ft into the gravel beds near the Wind River (Fig. 5). These wells are capable of producing over 15,000 bbl of water per day through 5-in. production columns. The natural filtration of the snow-fed river waters through gravel beds into the well bore makes water treatment unnecessary. To assure non-turbid water, however, three 10 ft pressure-type sand filters have been installed. Chemical analyses indicate that the fresh supply water is compatible with the Tensleep water. The plentiful volume of fresh water also makes it the most economical and mechanically practical injection medium.

Water analysis patterns have been made of the fresh supply water and of the produced Tensleep water from those wells that are making water. Plans call for periodic produced water sample tests every three or four months. From these water analysis patterns, calculations can be made which will show the relative increase of fresh water production over the reservoir water production. The fresh water front can be plotted as it progresses across the field.

Two of the three supply wells are equipped with Moturbo Peerless pumps. (Fig. 6). These pumps are powered by 30 horsepower, 1760 rmp, 440 v, 60 cycle, vertical, hollow-shaft motors which give a 225 gpm discharge against 394 ft of head. One supply well, which will be used as a standby, is powered by a Waukesha 195 GKU natural gas engine. The supply water is delivered through four and one-half miles of 8-in. welded line which is wrapped and buried six feet deep. The water contains less than 1 ppm of iron and the alkalinity as calcium carbonate shows an under saturation of 10 ppm. No treating is necessary; however, filtration is being used to decrease or to guarantee no turbidity of the injected water.

Supply Tanks. Two 1500 bbl, raw water storage, three-ring National bolted steel tanks and two 1500 bbl filtered water tanks "ride" on the supply system. Air actuated Kimray liquid level control valves keep the tanks at a high level. Each tank is equipped with a 12¾ in. by 10 ft, 500,000 Btu/hr, "U" firetube mounted in a standard cleanout stave with standard extended cleanout box and welded into a special cleanout cover. The system is semi-closed with the tank thief hatches being the only access to air. (Figs. 7 and 8).

Filters. The filters have a combined capacity of 472 gpm at a filtration rate of 2 gpm per square foot of filter media bed area. This filtration rate exceeds our greatest volume requirement of 437 gpm, or 15,000 bbl per day. The raw water is delivered to the plant with approximately 50 psig pressure which is ample pressure to circulate the water directly through the two normally idle centrifugal pumps connected to Waukesha 195 GKU gas engines and through the three Infilco

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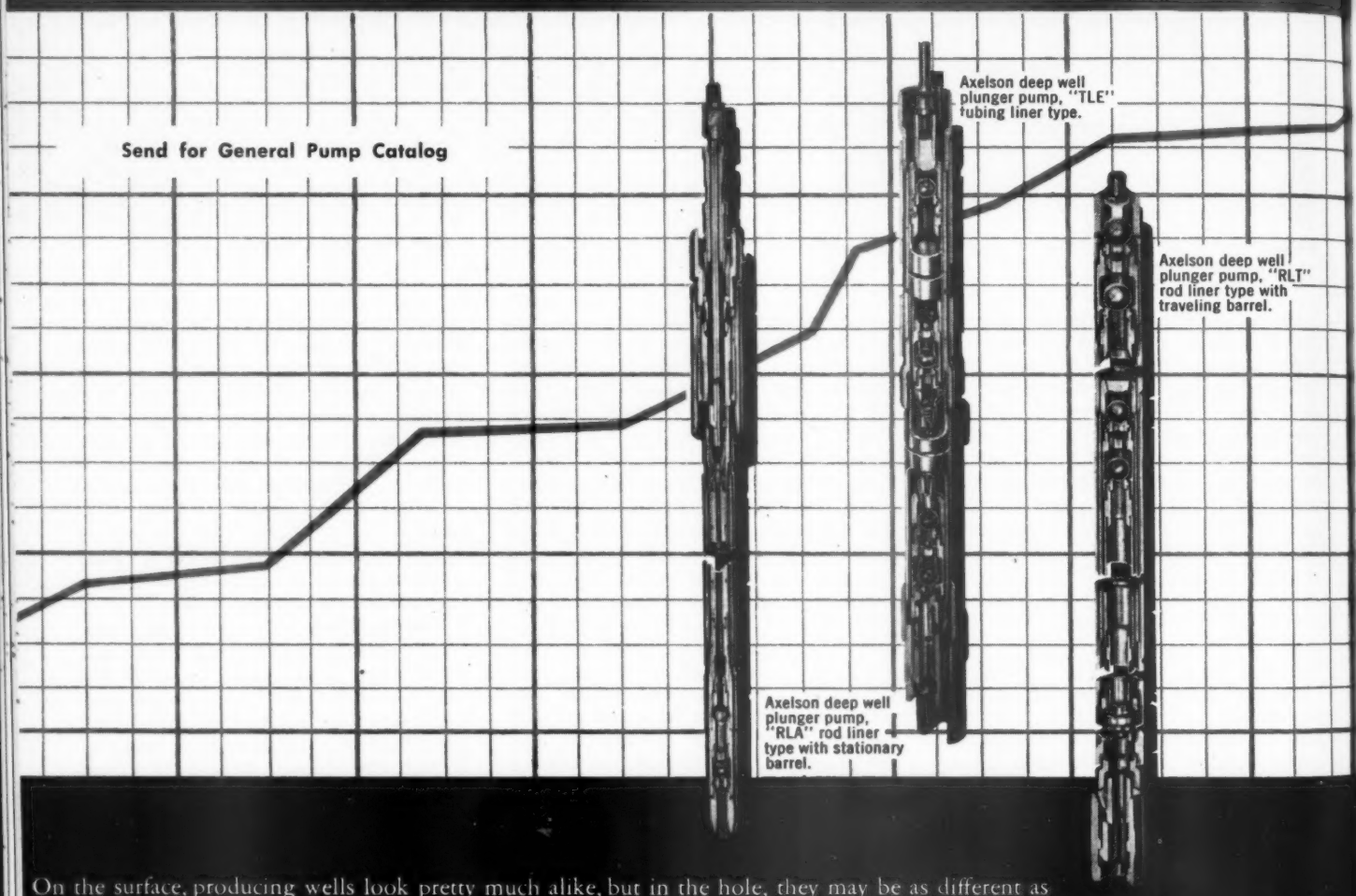
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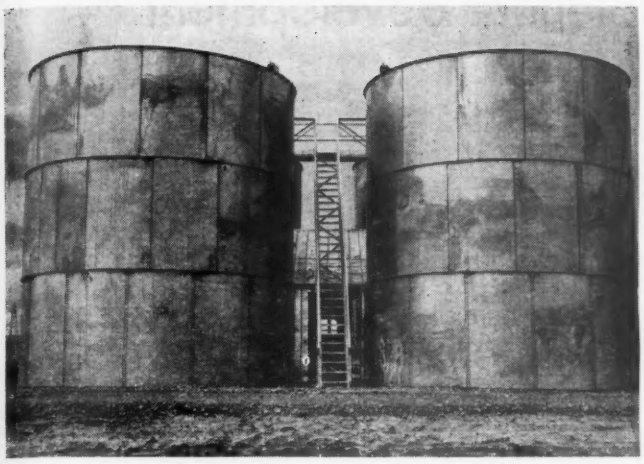


FIG. 7. Water supply tanks.

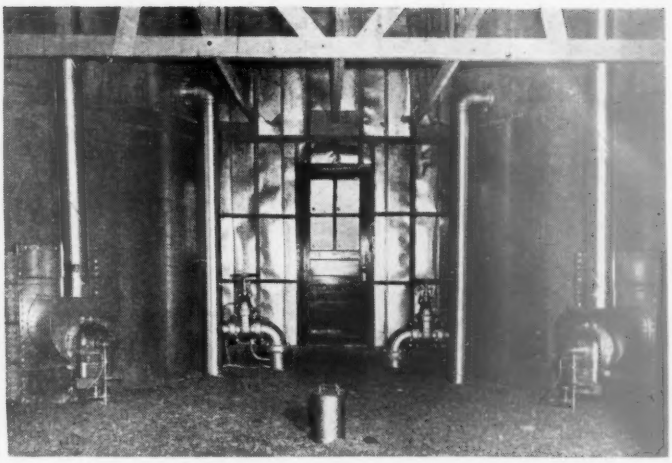


FIG. 8. Water supply tanks.

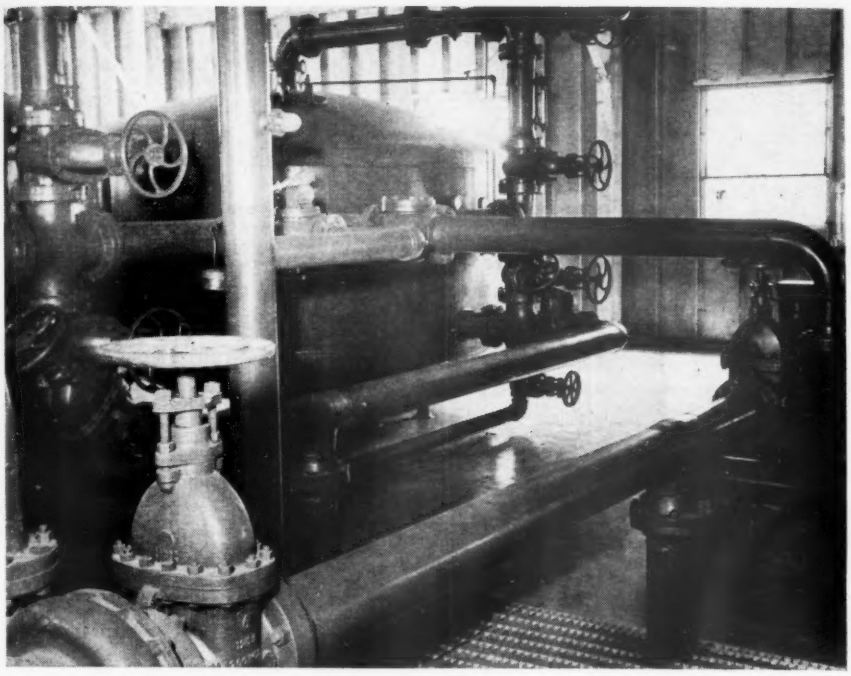
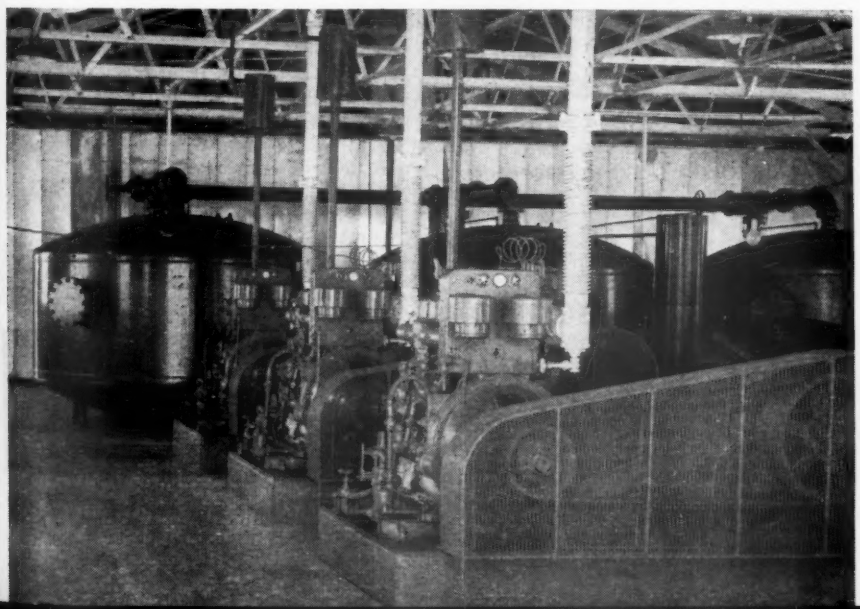


FIG. 9. FILTER system, shows filter pumps, filter manifold, and filters.

FIG. 10. INJECTION pumps and engines.



sand pressure-type filters. (Fig. 9). The pressure filters are designed for 75 psig working pressure with a high safety factor. Whenever the filters require backwashing, the Gould centrifugal pumps will be started, and the additional volume of water over and above that being supplied from the supply wells will be drawn from the water storage tanks. The filter input and output header piping system is so designed as to allow full plant injection operations to continue even though one or two filters are being back-washed. (Fig. 9). After leaving the filters the filtered water enters two 8-in. parallel lines which supply low pressure water to the two three-unit banks of high pressure triplex injection pumps. One end of one 8-in. filtered water line goes to the storage location and maintains two 1500 bbl tanks of filtered water, while the other end supplies water to the suction side of three triplex pumps. The other 8-in. supply line carries filtered water to the opposite bank of the triplex pumps. Both supply lines run through a type "R", Model No. 1610, Young Radiator single pass heat exchanger capable of handling approximately 4,000,000 Btu per hour heat load.

Plant Pumps and Engines. The six Oil Well 36-P triplex pumps are powered by Waukesha 145 GKU gas engines. (Fig. 10). Space is available for the addition of two or more units when and if needed. These engines are equipped with straight gas carburetors with cold intake manifolds, aluminum pistons to give 7.2:1 compression ratio for high altitude operation, and twin disc clutch power take-offs. The jacket water from the engines circulates through the two single pass heat exchanger shells at approximately 440 gmp with an accompanying pressure drop of two pounds and is cooled by the supply water flow through the main lines. A water make-up or volume tank "rides" on the system to take care of any losses. Temperature wells are installed in the inlet and outlet of the parallel heat exchangers. A 6-in. gate

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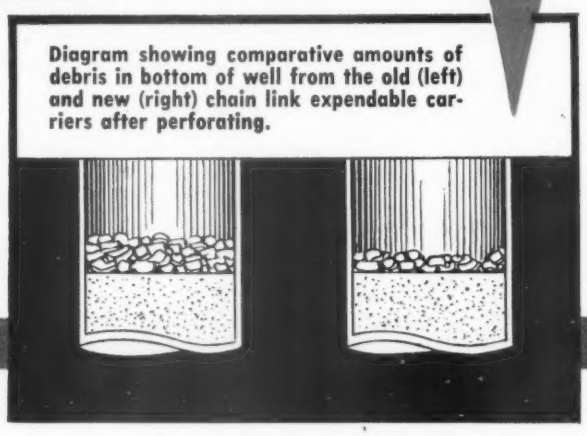

Diagram showing comparative amounts of debris in bottom of well from the old (left) and new (right) chain link expendable carriers after perforating.

Johnston Testers' engineering program has produced an advanced design of the Expendable Jet Gun used in their Shoot-Produce Method of well completion. A redesigned chain link expendable carrier and a 32 gram charge, manufactured by companies who specialize in this work, reduces the debris from perforation to about half that of the previous design.

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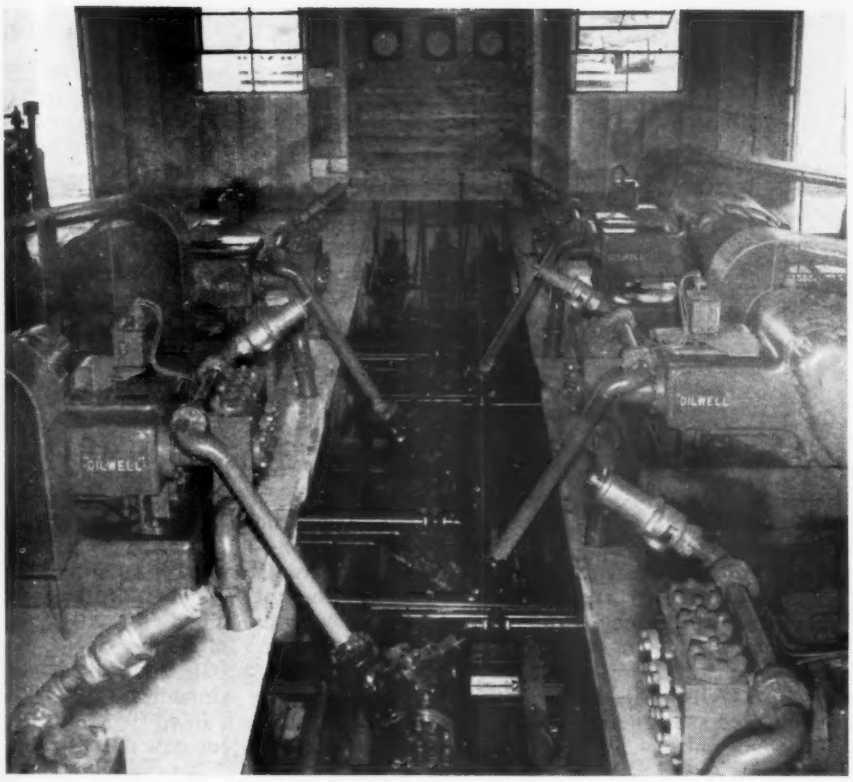

FIG. 11. INJECTION pumps and engines.

valve between the two heat exchangers affords a by-pass which can be opened to by-pass the regular volume in case the hot jacket water is being cooled below the temperature at which the engines operate most efficiently.

Each engine is equipped with governor, oil filter, water cooled exhaust manifold, safety switches, gauges, temperature and pressure cut-offs, Fulton Sylphon temperature regulator with three-way by-pass valve to thermostatically maintain the jacket water at the desired temperature, and Wahlberg-McCreary air starters.

Surge tanks are installed on each engine to provide ample capacity for expansion of the coolant and to maintain a positive head on the water circulating pump suction. (Fig. 10).

The high pressure injection pumps are the horizontal, single action, 3-cylinder, Oil Well No. 36-P, triplex plunger pumps complete with forged steel fluid end and porcelain plungers. The pumps are identical to allow field personnel to change liner plunger sizes from pump to pump, thus giving a high degree of flexibility to meet the various pressure-volume conditions. When changing from one size to another, it is only necessary to install the proper size chevron and rectangular packing, stuffing box bushings, gland bushings and lantern rings. It is unnecessary to disassemble at the cross head, because the plunger head can be unclamped from the plunger extension. (Fig. 11). It was anticipated that three intake wells would have different injectivity capacities. Therefore, the pumps were equipped with 2½ in., 2¾-in., and 3-in. plungers to give a theoretical capacity range of 53.5 to 77.2 gpm per pump at 140 rpm.

Plant Building. The central plant building is a 50-ft wide by 85-ft long Parkersburg prefabricated steel building. Equipment occupies about 50 ft by 70 ft of the space, and the remaining portion contains garage, bathroom, and office space. (Fig. 12).

A graded, concrete-lined trench extends throughout the equipment portion of the building. The plant floor overhangs each wall of the trench upon which serrated A. O. Smith grating is supported. (Fig. 13). All piping, except the suction lines, discharge lines, and exhaust header, is below floor level. The main trench contains three elevations of piping. The bottom elevation of piping includes two 8-in. supply lines; the center elevation of piping includes the hot and cold 4-in. jacket water circulating lines; and the top elevation of piping includes the 2-in. air line, and the 3-in. gas line, and the three 4-in. high pressure injection lines. Elevation two is attached by bolts and clamps to the base of H-beams placed in cutouts in the trench walls, and elevation three is attached by bolts and clamps to the top of these H-beams. Smaller water, air, and gas risers and

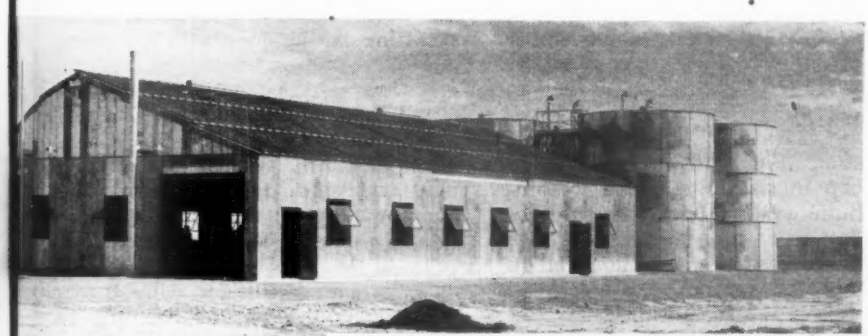

FIG. 12. PRESSURE maintenance central plant, above.

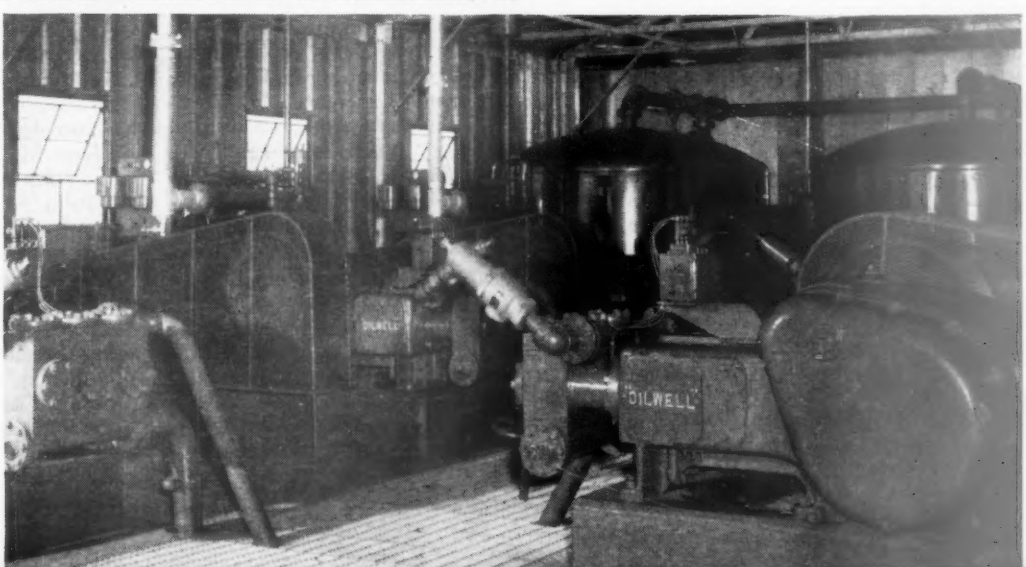

FIG. 13. PRESSURE maintenance central plant, right.

lines pass through smaller trenches alongside the pump foundation blocks. These trenches are covered with treadplate.

A 4-in. line is used as a common header with all pumps discharging into it. High pressure block valves are installed between each discharge line from the six triplexes. One end of the 4-in. line goes directly to Tribal C-6 intake well, the other end loops and goes to V-1 intake well, and a line from the middle of the common header serves R-1 intake well. (Fig. 11). With the valve arrangement, it is possible to split the pumps to the injection wells as desired to give maximum flexibility. Each of the injection lines pass water through a Robinson type "E" orifice fitting which allows the plant operator to change orifice plates without taking the line out of service. Type 27 electrically operated Foxboro flow meters are connected to the Robinson orifice fittings. Each meter is equipped with a static pressure element to measure from 0-1500 psi, a differential pressure element to measure from 0-50-in. of water, and an electric integrator. The integrator is a convenient means of totalizing the flow through the system over a given period of time. (Fig. 11).

Two 9⅝-in. Armco spiral weld lightweight pipe exhaust headers are installed in the roof trusses of the building, into each of which three Waukesha 145 GKU engines and one Waukesha 195 GKU engine exhaust. Since the engines are mounted on slide rails, it was necessary to put a short section of flexible pipe between the engine exhaust connection and the header. The exhaust pipe from the engine to the header is 4-in. nominal size. This pipe enters the header at a 45 deg angle and extends into the header enough to prevent any condensation from draining into the engine. (Fig. 10). Shop made clappers quite similar to tractor exhaust weather caps are tacked to the inclined top of each exhaust inside the headers. These are balanced to give the minimum amount of back pressure to the engines. The two headers are welded into 10¾-in. casing stand pipe outside the building. This stand pipe extends six feet below ground level and is packed with gravel for four feet with a two foot concrete cap on top. The top end of the stand pipe extends above the eave of the plant building.

A 50 ft by 200 ft by 6 ft waste pit is provided, into which a 16-in. pipe drains all filter back-wash water and plant wash-down water. This pipe is buried from the edge of the pit to the plant.

The gas source is from Tribal C-7, which produces from the third Frontier sand. The gas supply from the gas well enters an oil filled gas scrubber at 75-90 psg pressure and then flows into a master Fisher type 630 "Big Joe" regulator in which the pressure is dropped to 30 psig. It then flows through a one-inch Fisher type 730 BH regulator installed immediately ahead of the engine regulator. The pressure is then reduced by the engine regulator to an operating pressure of six to eight ounces.

FIG. 14. INTAKE well, Tribal V-1.

Injection Wells. (Fig. 1) Tribal V-1 was completed at a total depth of 7485 ft GL on November 4, 1952. (Fig. 14). A string of 5½-in. casing was set at 7484 ft GL and was selectively perforated from 7473 ft to 7275 ft GL, with proper blank spaces left for packer seats. After acidizing and cleaning out, the well took 6620 BW/D at 1150 psig surface pressure on a spinner survey injectivity test. The 4-in. high pressure line was laid 6 ft below ground level from the plant location to the well sites, some 2800 ft distance. This well is approximately eighteen feet lower than the central plant elevation.

Tribal C 6 on the North plunge, was originally completed as a dry hole at a depth of 7394 ft GL in November 1945. Anticipating the need for water input wells later, the casing was left in the hole and the well used as a Tensleep pressure observation well. When communication with the productive Tensleep formation in North Steamboat Butte was proved by pressure observations over several years, the well was recompleted as an injection well on November 30, 1952 in open hole from 7321 ft to 7512 ft. An injectivity test by spinner survey indicated that the well was capable of taking 7527 BW/D at 275 psig. Tribal C-6 is 230 ft higher than the plant elevation and is some 13,200 ft from the plant.

Tribal R-1 was drilled to a total depth of 7393 ft GL on March 20, 1952, with 5½-in. casing set at 7392 ft GL. It was plugged back and completed as a water input well to 7382 ft GL through selective casing perforations from 7381 ft to 7214 ft GL. An injectivity test by spinner survey indicated that the well would take water at the rate of 6624 BW/D at approximately 1200 psig. This well is located 3968 ft from the plant location and is 47 ft higher in elevation. Each well head is equipped to allow the running of a pressure bomb or a small water thief through a lubricator without dismantling the head.

Injection of water for pressure maintenance began on July 3, 1953, into the three intake wells. Through August 10, 1953, 431,500 bbl of water had been injected into the Tensleep reservoir, while calculated natural water influx amounted to 283,500 bbl and fluid withdrawals totalled approximately 400,000 bbl. During this initial test period, a net volume of approximately 315,000 bbl of stock tank fluid was placed in the reservoir and the aquifer.

Material balance calculations, based on fluid-level data obtained in September, 1952 and May, 1953 when the average bottom hole pressures were respectively 2556 and 2411 psi, indicated that the average natural water influx during this period was 7268 bbl per day. During this same time interval, the total volume of reservoir withdrawal amounted to 2,017,869 bbl of fluid or 8340 bbl per day.

North Steamboat Butte field had produced approximately 12,500,000 bbl of oil through July, 1953.

It is quite obvious now that as much as 20,000 bbl of water per day can be injected at safe injection pressures with minor pump plunger-liner changes. This project can be carried on in a nearly ideal condition because of the favorable lease ownership and because of the very favorable reservoir characteristics. A natural water drive exists in North Steamboat Butte field, but an extraneous supply of makeup water was necessary to supplement the natural water influx. It is understandable that pressure maintenance permits more economical operation of producing wells, because mechanical means of lifting can be done with less operational difficulty and less expenditure of energy. Consequently, we can materially save operating expense.

Detailed plans were drawn for each phase of the physical plant and facilities, and all supervisory work was done by company personnel.

The United States Geological Survey and the Department of the Interior's Bureau of Indian Affairs were very cooperative in, and receptive to, the pressure maintenance project.

Acknowledgement. The writer expresses his appreciation to the British-American Oil Producing Company for permission to publish this paper and acknowledges the advice given by Glenn M. Stearns, Wesley W. Moore, and John J. Arps.

John J. Arps, manager of the research and economics department, British American Oil Producing Company, initiated a great portion of the technical thinking and planning behind the early development of this field and the pressure maintenance project.

Special thanks are due Oil Well Supply Company for their courtesy in obtaining the pictures that are printed herein.

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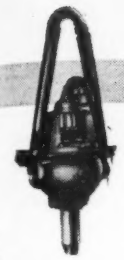

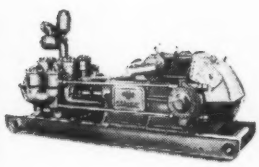

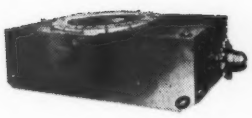

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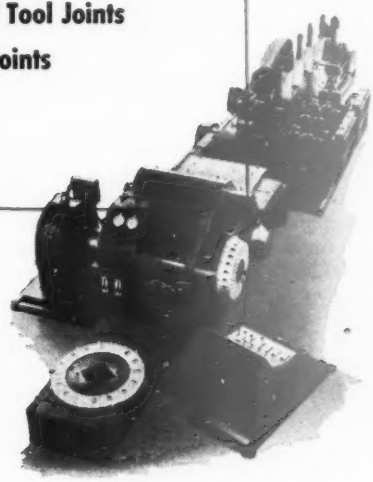

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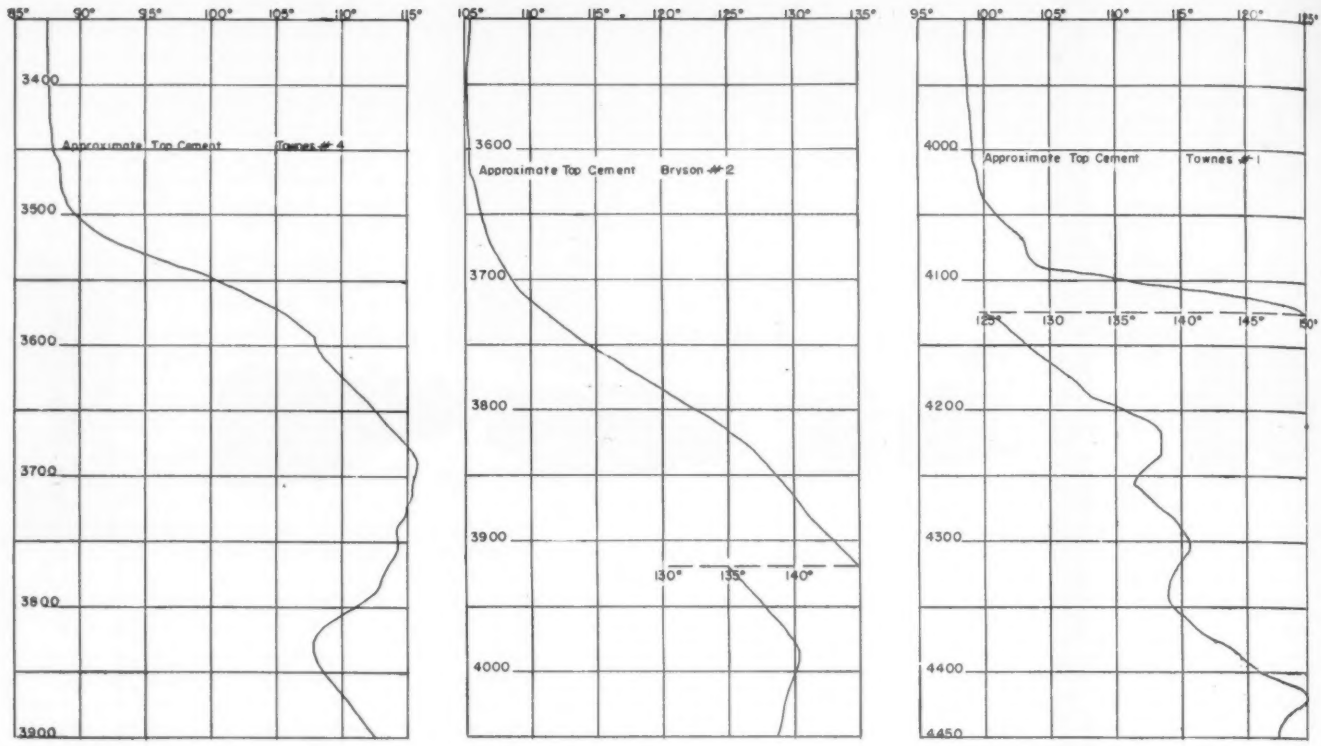

50-50 Pozmix S cement, 2 per cent gel

Portland cement, 4 per cent gel

Portland cement, 4 per cent gel, 20 per cent perlite

FIG. 1. TEMPERATURE survey charts from Townes No. 4, Bryson No. 2, and Townes No. 1.

Use of Pozzolan Cement in Prentice Field

Additive proves beneficial in reduction of completion failures due to incomplete water shut-offs

J. P. SCHMALZ

POZZOLANIC cement,* a material composed of portland cement, a natural pozzolan,** and bentonite, has proved to be an excellent material for oil well cementing in the Prentice field, Yoakum County, Texas. This type of cement has several desirable features, namely, excellent perforation characteristics, low permeability, resistance to corrosion, good pumpability, and low cost.

The formations encountered in the Prentice field are comparable to most other areas in West Texas. Wells in this field produce from two zones: the Glorietta dolomite, at depths between 5900 and 6000 ft, and the Clearfork dolomite, at depths between 6400 and 6500 ft. The usual water sands are encountered in the first 400 ft of drilling. The sections from 400 ft to approximately 2500 ft are composed mostly of red beds with streaks of shale and anhydrite. The red beds are underlain by approximately 1600 ft of salt. The San Andres lime, between 5200 and 5800 ft, is a very porous section containing a considerable amount of sulfur water and occurs immediately above the Glorietta pay. A good cementing job is essential for the protection of the Glorietta zone because of this San Andres sulfur water above and bottom salt water in the pay section.

In the past, various types of cements and admixtures were used on the surface, intermediate, and oil strings in this field. In most instances, regular neat cement or neat cement with 4 per cent gel added were used. Occasionally, small quantities of perlite were added to the 4 per cent gel cement mixture.

Recent practice has been to use a 50-50 mixture of pozzolan and portland cement containing 2 per cent bentonite by weight of the mixture. The cement qualities most desirable for properly cementing casing in the Prentice field are exhibited by this mixture. The pozzolan used is a siliceous material of volcanic origin and is classified as a nat-

*Trade name is Pozmix Cement.
**Trade name is Pozmix S

The Author

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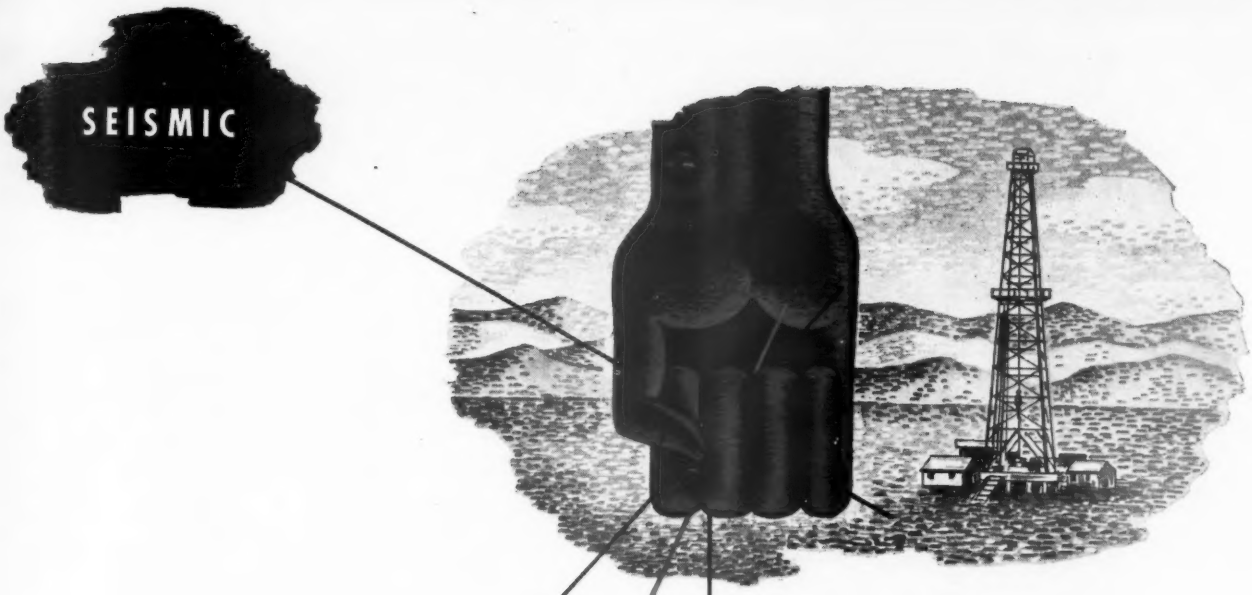

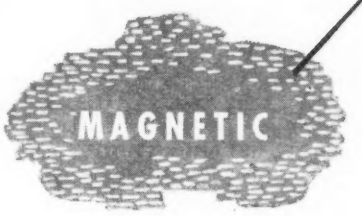

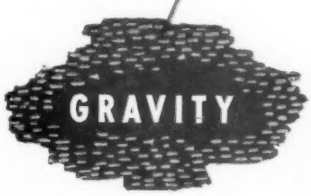

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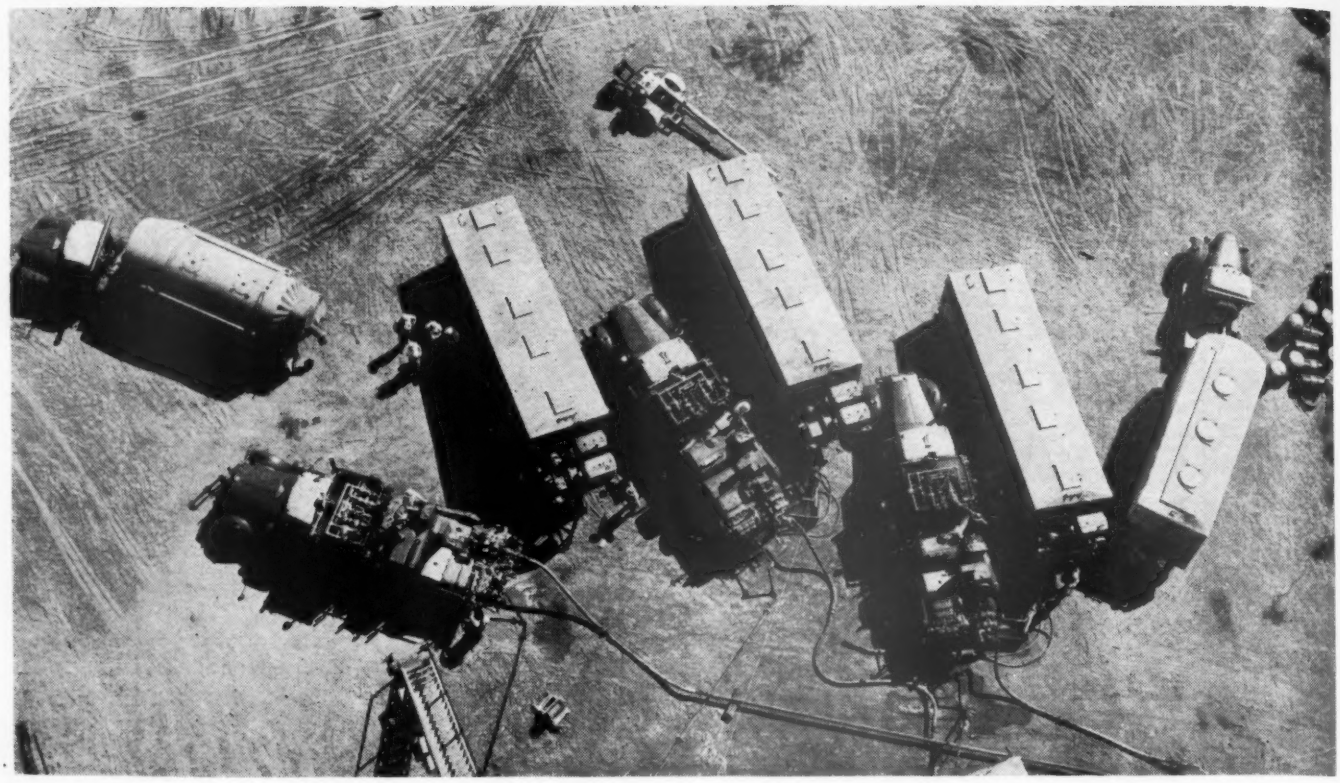

FIG. 2. CEMENT equipment in place on West Texas casing cementing job.

ural pozzolan. It has no cementing properties of its own, but combines with calcium hydroxide, a product of cement hydration, to form insoluble compounds that have cementing properties that contribute to both strength and water tightness.[1]

In this reaction, all free lime formed during the setting of cement reacts with the pozzolan. This creates a material having a low permeability, and the absence of soluble calcium hydroxide, which might be leached from the cement by sulfate waters, makes it resistant to attack by corrosion.[2]

The pozzolan used in this mixture has a specific gravity of 2.8 as compared to 3.1—3.2 for portland cement.[3] This difference in specific gravity results in a reduction of slurry weights from those of slurries with comparable consistency of portland cement.

Neat cement cured for 24 hours, or more, is brittle and will exhibit cracking when perforated, with even more severe shattering occurring as the cement ages and increases in strength.[3] This shattering could be sufficient to admit unwanted water into the Prentice field Glorietta wells where casing was set through the pay interval and gun perforated.

Strength

In the past few years, lower strength cements have been accepted by the industry and the current safe minimum in compressive strength is approximately 500 psi.[4] Note that cements containing pozzolans exhibit lower strengths at early ages; however, the strength will later approach or exceed the strength of corresponding slurries prepared with a neat portland cement.[1,2]

Table 2 illustrates that the strength of pozzolan cement is doubled in between one and two days at all temperatures. A similar increase is reflected between the two and seven day compressive strengths of pozzolan cement. These data show that portland cement is approximately four to five times stronger than pozzolan cement after 24 hours setting time, but after seven days setting time, due to the pozzolanic reaction within the material, the strength of portland cement is only about two and a half times greater than that of pozzolan cement.

In addition to a 24-hr compressive strength that is above the safe minimum, pozzolan cement has the particularly desirable quality of resilience. This property, which is lacking in neat cement should be an aid in maintaining permanency of the cement bond behind the casing while drilling below the casing shoe after cementing.

Formation Temperatures

The formation temperatures in the Prentice area are comparable to most temperatures in West Texas and New Mexico at corresponding depths to 6500 ft. Here the static temperatures are moderate and seldom exceed 135 F at 8000 ft. A study of Tables 1 and 2 will give a general indication of the strength developed in pozzolan cements at the different formation temperatures in the Prentice field. These values determined at atmospheric pressures would probably be somewhat higher when set under hydrostatic pressures in the well.

Permeability

The permeability of pozzolan cement has been found to be very low. Actual tests have been made on samples of set materials taken from the mixing tub at the well. These samples were found to have permeabilities of considerably less than one millidarcy. Although these samples were allowed to cure at atmospheric conditions, corresponding samples set under hydrostatic pressure in the well would probably have much lower permeabilities.

Cementing Practice

The normal practice in this field is to set a 9⅝-in. intermediate string of pipe

TABLE 1.

Compressive strength[5] psi

Pozmix S—Portland Cement versus Neat Portland Cement

50–50 Pozmix S—Portland Cement (2% bentonite)

Temperature, F	24 hours	48 hours	7 days
80	230	975	2015
100	530	1335	2765
120	850	2000	3110
140	1340	3140	3600

Neat Portland Cement

Maximum water

Temperature, F	24 hours	48 hours	7 days
80	1710	3230	6060
100	2660	4060	6535
120	3230	5360	6990
140	4300	6610	7485

TABLE 2. Formation temperatures in the Prentice field.

Depth, ft	Temperature, F
2000	90
4000	107
6000 (Glorietta)	111
6500 (Clearfork)	120

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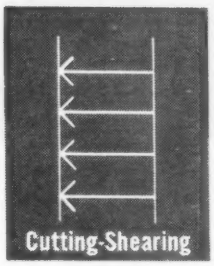

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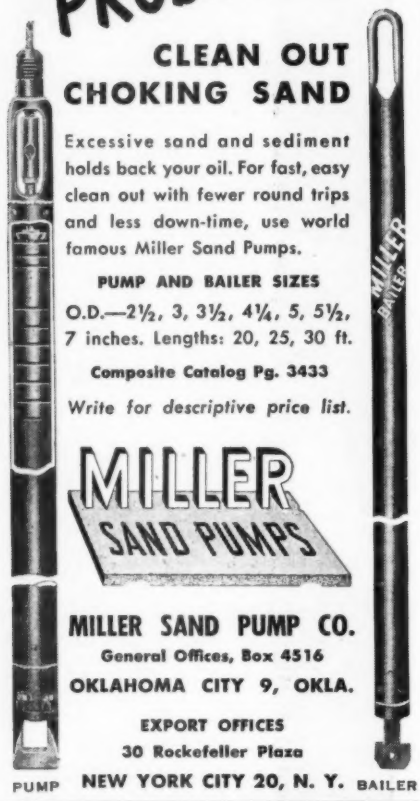

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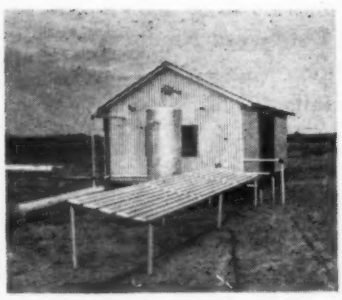

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to approximately 2500 ft, about 15 ft into the Rustler anhydrite, which is just above the salt section. A 7-in. or 5½-in. production string is set on top or through the production zones.

When casing is set through the producing zones, it is selectively perforated for completion. On two of these occasions, the pozzolan cement was "tailed in" with 200 sacks of neat cement. After perforating, water was produced. It was then necessary to squeeze these wells to shut off the unwanted water. On other wells with similar conditions, pozzolan cement was used for the entire job and water was not present in excess after perforating.

On numerous occasions it has been observed that the pressure required to place these pozzolan slurries behind the pipe required from 100 psi to 300 psi pressure less than that for portland cement or mixtures of portland cement and perlite.

Job Data

At the present time pozzolan cement has been used on 24 wells for a total of 44 jobs. A breakdown of these is shown in Table 3.

TABLE 3. Cementing jobs with pozzolan type cement.

Type job	Number	Sacks	Average sacks
Surface	1	200	200
Intermediate	19	18,000	946
Production:			
Long liners	18	27,000	1500
Full strings	6	4,200	700
Total	44	49,400	1120

Temperature Surveys

The heat of hydration of pozzolan cement is normally somewhat less than that for neat cements.[6] The lower heat is due to the replacement of cement with pozzolan, which also liberates heat but at a much slower rate. This, however, does not appear to affect temperature surveys in locating the fill-up behind the pipe. Heat liberated while setting is sufficient to indicate a sharp break at the top of the cement. These surveys are normally run 12 hr after cementing.

Fig. 1 compares the temperature surveys of a pozzolan cement job with those of a gel cement and perlite cement job in the Prentice area.

Waiting Time on Cement

The waiting time on pozzolan cements will vary according to the type of job. The WOC time for this material corresponds to that for portland cement and is influenced by such factors as temperature, pressure, type of job, drilling contract, and strength desired before resuming drilling operations. Considering these factors, it has been the practice in this field to wait 36 hr on surface pipe, 48 hr on intermediate strings and 72 hr on liners or oil strings.

Should shorter WOC times be desired for any particular jobs, additional early strength may be obtained by the addition of small amounts of calcium chloride, mixed in that portion of cement just behind the lower joints of pipe.

Fill-Up

When using caliper surveys to determine the volume of slurry required for a particular job, it has been the practice to add an additional 10 per cent above the calculated amount to insure fill-up. On jobs where pozzolan cement was used, this excess was normally circulated out. With other types of cementing materials, the excess circulated out has been variable with the amount of cement used.

Summary

The experiences of one operator in the Prentice field between September, 1952, and August, 1953, indicate that pozzolan cement produces consistent results. The shattering effect of gun perforating has been reduced, contributing to more water free production. The WOC time is consistent with normal practice. The overall cementing costs have been reduced. Moreover, the slight permeability, which was of some interest in the beginning, appears to be of no consequence insofar as migration of fluids in and around the pay section is concerned.

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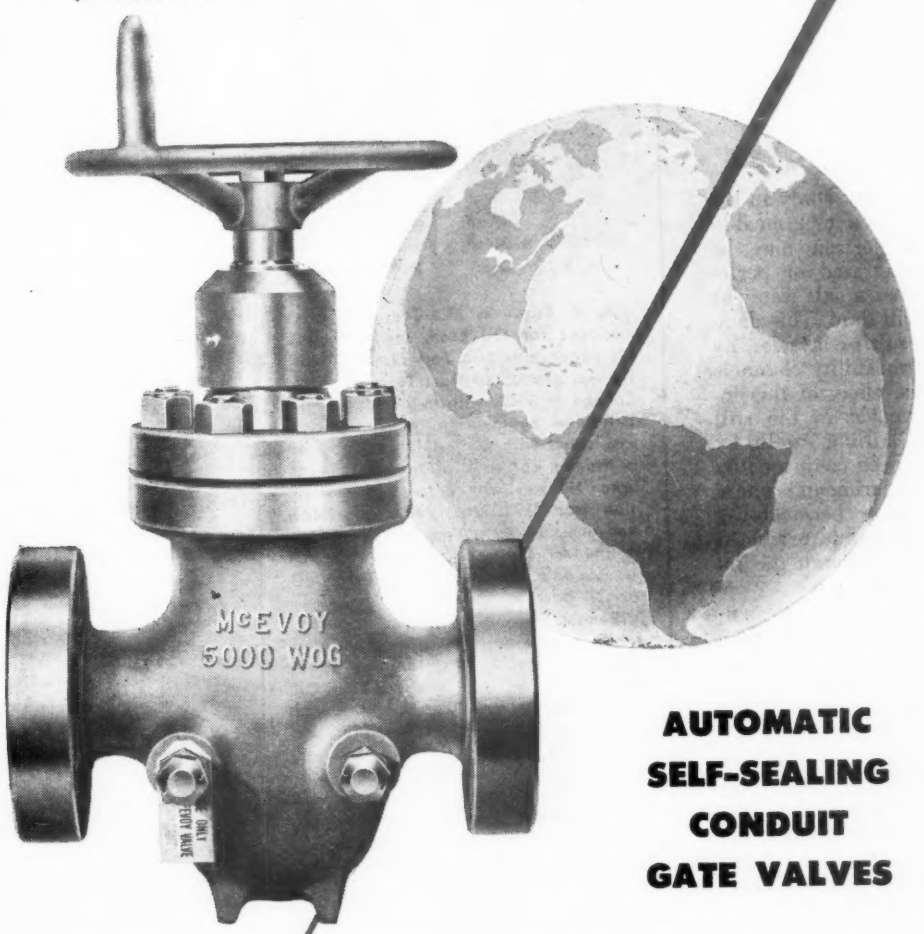

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Uses and Handling of Oil Base Mud

Better protection of water sensitive zones while drilling of perforating may be secured by use of special fluid

A. K. BROWN and B. H. BURKS

Oil base drilling fluids are experiencing ever increasing use throughout the active drilling areas of this country and abroad. This report will briefly explain the uses of oil base mud, and will summarize those handling procedures found, by rig crews and operators through long and varied experience, to be most efficient and least complicated.

Purpose of Oil Base Mud

Years of experience and study in the field have shown the effective permeability of a productive horizon may be damaged if it is penetrated or perforated while using either a salt water or a fresh water base drill fluid. This damage is in part the result of invasion by free water of the permeability channels of the formation. The effect of this invasion is clearly revealed in the still common practice of "killing" wells by water squeeze. It has been confirmed by recent laboratory experiments where complete and permanent permeability blocks have been deliberately produced in some oil sand cores through the injection of salt water.

Too, the hydratable clays and bentonites contained in water-base mud prevent or seriously hamper flow into the well bore when they enter the formation. If the oil sand already contains bentonites and clays, as is often the case, the damaging effect of water invasion is increased for it has been established that water invasion extends farther into the formation than does mud particle infiltration. When water invades a sand containing hydratable material, that material swells thereby restricting or completely blocking the permeable channels through which oil could otherwise flow. It is the purpose of oil base muds to eliminate this damage by the waterless fluids in drilling or perforating use of the pay section.

Uses of Oil Base Mud

Uses of oil base mud vary with the locale in which it is used. Some oil producing areas are made up predominantly of thick sections that may be completed in open hole; some areas contain thin multi-pay fields where completions are made by perforating after casing has been set through the oil sands; while in other areas such problems as heaving shale, thick salt or anhydrite sections or other troublesome drilling conditions are encountered. In areas such as the Los Angeles basin where the majority of the wells completed in 1952 were drilled-in with oil base mud, oil sections are thick and may be completed in open hole. In such wells it is common practice to drill to the casing point with water-base mud, set casing, change over to oil base mud, and drill the oil sand with the oil base mud.

Along the Gulf Coast where sections are thin and often multiple, the well is drilled to total depth with water-base mud and the entire length of hole cased off. Completion is then effected by use of one of the perforating techniques now available. Experimental research already completed and that yet in progress has proved that damage, often irrepairable damage, results when jets or bullets are fired through water base muds or water. Hence, it has become the practice of many to spot weighted oil base mud opposite the section to be perforated just prior to running in with the gun, thus accomplishing a semi-oil base completion. It has been found that in perforating through water-base muds, the mud is carried with considerable force into the newly opened shot-hole where it is compacted by pressure and dehydrated by heat to form a plug that immediately seals the hole. Experiments have shown that in some areas as much as 85 per cent reduction in permeability may accompany perforations in water-base muds. If perforating is carried out with oil or oil base mud in the hole, the perforations remain clean and open.

Extensive use of the oil base perforating technique along the Gulf Coast has led to almost phenominal results. Stripper wells have been restored to top allowables; productivity indices have been multiplied many-fold. In one field, a major operator has upped the field production over 1600 bbl a day since the inauguration of an oil base mud work-over program in which all recompletions are made by perforating through oil base mud. That operation has been in effect for shortly over one year.

In troublesome drilling areas, oil base muds have proved their worth. A recent job in the southern part of Mexico had to be abandoned when a heaving shale section was encountered. Three attempts to penetrate this zone met with failure with a considerable expense and loss of expensive drill pipe. The rig was moved one location away on 40-acre spacing, and an attempt made to put down the hole with oil base mud. More

The Authors

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B. H. Burks

A. K. Brown is Mid-Continent sales manager for Oil Base, Inc., and has his headquarters in Fort Worth, Texas. He was graduated from Texas A. & M. College in 1938 with a B.S. degree in petroleum engineering. A brief period was spent with Shell Oil Company as a trainee engineer in the East Texas area. He was with Baroid Sales Division from 1940 to 1946, with three and one-half years time out for service in the Air Force. Separated from the service as a captain, he joined the staff of Oil Base in 1946.

Bennett H. Burks received a petroleum engineering degree from the Colorado School of Mines in 1951, after which he was with Richfield Oil corporation as a roustabout, then joined International Drilling Company. He also spent a short time with the Fred Johnson Drilling Company prior to being employed by Oil Base, in October, 1951. Before receiving his engineering degree he spent six years in the Air Force, having served as a B-29 pilot during World War II.

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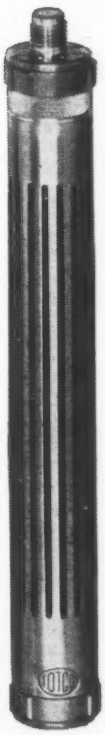

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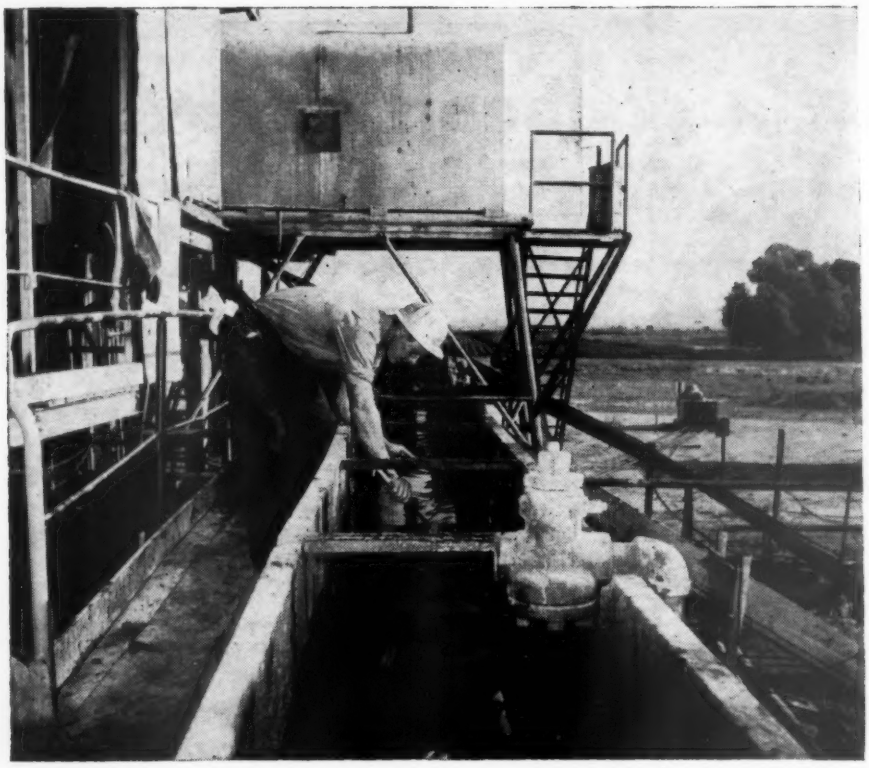

DERRICKMAN Clarence A. Craig catches a sample of oil-base mud at Ohio's Kern County Land Company "A" 72-4. The Ohio changed over to oil-base mud at 10,955 ft in this well, and has used this type of mud continuously in drilling the remainder of the hole.

than 3500 ft of heaving shale were drilled in 10 days, the hole remained to gage throughout the drilling operation, and pipe was run with ease upon completion. Salt sections and anhydrite present no problems when drilled with oil base mud. Salt, anhydrite, and heaving shales are extremely sensitive to water. As oil base mud is completely waterless, the one element that produces an adverse reaction with these troublesome conditions is excluded.

Oil base muds have a definite application in deep drilling. Through better lubrication of the cutting tools, the use of oil base mud permits longer time on bottom. By maintaining a slick hole, in laying down an extremely thin wall cake, and by reducing torque through drill-stem lubrication, oil base mud eliminates many mechanical difficulties. Fishing jobs, if they become necessary, are more readily accomplished due to maintenance of gauge hole and thin filter cake. As oil base mud becomes thinner with heat and since it contains no bentonites or clays, the problem of high temperature gelation is eliminated. Of the three wells drilled to below 20,000 ft, oil base mud was used in two, one of which is still in progress and holds the world's depth record. The other has yet to be completed, and the oil base mud still stands in the hole. The projected depth for the West Coast job is 22,000 ft. Mud maintenance on the Gulf Coast job, which had a bottom hole temperature of 389 F, averaged less than $40.00 per day while maintenance of the mud in the West Coast job is averaging less than $50.00 per day. Expense of maintenance on a very costly water-base mud could be many times greater than that for either of the two oil base jobs, or for them both.

Oil base mud affords excellent core recovery even in the softest of formations. Water dissolves the matrix of many formations causing the grains to fall apart. In such formations, coring with water-base mud becomes difficult. The use of water-base mud in coring for water information leads to misinterpretation due to the filtrate which invades, and often flushes, the core. A cost analysis on the per foot cored basis by a Mid-Continent major who used a system of oil base mud in several jobs shows the cost of oil base mud to be less than 10 cents a barrel more than a low cost water-base mud used for the same purpose.

Storage and Handling

The following recommendations relative to equipment will minimize waste and facilitate handling of oil base mud:

1. *Central Storage.* Any standard oil field storage tank or battery of tanks will be suitable for storage of oil base mud. In order to minimize contamination of the mud, these tanks should be clean and free from crude oil and water. Upon standing quiescent for several days, oil base mud develops a high gel. To provide ease of handling when removing mud from storage, some means of agitating the stored mud is recommended. A double, bottom-type mud gun will prove most adequate. Storage tanks should have water tight thief hatches, gauging ports, and inspection manholes to prevent water entry during periods of rainy weather. Storage tanks should be free of leaks to prevent wasteful loss of mud.

2. *Steel Mud Pits.* Any standard design of mud circulating pit or system of pits will be suitable. Steel pits are essential to prevent the loss of mud due

GUNNING pits at Kern County Land Company "A" 72-4. Mud system of the Ohio's world's record drilling well holds roughly 1750 bbl of oil-base mud at record depths below 20,522 ft.

to seepage as is encountered in earthen pits. In working over a well it is seldom necessary to utilize more than one mud pit. To prevent recirculation of the material removed from the well, however, a single baffle to separate discharge and suction ends of the pit should be provided.

3. *Mixing Facilities.* A mud mixing hopper is required to insure proper blending when weighting or treating muds. To further agitate, mix, and blend the mud during these operations, mud guns are recommended. It has been found that best mixing is accomplished through the use of both top- and bottom-type guns.

4. *Removal of Cuttings.* Use of a vibrating shale shaker provides most efficient removal of cuttings. If the amount of material removed from the well is small, a box screen placed at the flowline discharge will trap this material until the screen becomes full. It will be necessary to dump the contents of such a screen at frequent intervals during the clean-out operation; however, the need for this is eliminated if a ditch is provided and is shoveled at regular intervals if it is anticipated that a large volume of cuttings will have to be handled due to high drilling rates or an open hole change-over, then a long settling ditch in conjunction with one or more vibrating shale shakers and adequate pit capacity should be provided. A shaker screen of 12 to 20 mesh should be used, and the shaker should vibrate at its correct rated rpm. A 20 mesh screen can be used if it is scrubbed with a wire brush and solvent or mixing oil whenever circulation is stopped. A 12 mesh screen requires the minimum of maintenance. Do not wash screen with water.

5. *Special Devices.* A metal pan of suitable size and depth placed under the pipe rack will trap the drill fluid draining from the tubing or drill pipe after it is pulled from the hole. A line or trough connecting this pan to the flowline or to the pit will return this mud to use. Used drilling line laid in the bottom of the pan will prevent the puncturing and denting of the bottom as the pipe is racked.

All rubber that comes in contact with the mud should be replaced with oil resistant rubber or steel, the same as would be done for working with any oil. "Hycar" or a nitrile type of synthetic rubber has given excellent results to date.

A pipe wiper and a kelly wiper are greatly advantageous.

Sawdust should be provided to keep the rig floor clean (this should be swept up after each round trip or it will mat and pack down, losing its value).

A "wet-box" with a hose connection to the mud ditch is a comfort to the drilling crew and an efficient saver if it is ever necesary to pull the drill string "wet."

Ordinary precaution is all that is required in order to use oil base mud on a thoroughly economical basis. The major loss of this drilling fluid is usually due to carelessness or improper supervision. Leaking ditches, misaligned circulation system valves, waste in moving from one well location to another, or erroneous calculations when displacing the fluid with crude oil when the well is finished are possible causes for loss.

6. *General.* The most commonly used oil base mud is an extremely stable drilling fluid. Storing it for long periods produces no ill effects. Its gel is easily broken and fluidity restored with agitation. Crude oil and water are the main contaminents to be avoided; especially the crude oil. Water is very easily removed from mud, but the removal of excessive amounts will prove expensive. There are no special precautionary measures required in the handling of oil base mud. It contains no caustic or other such irritants; it will not burn nor blister the skin.

If central storage of the mud is such that production lines will be used to deliver mud to the various locations, it is recommended that these lines be drained to avoid contamination by crude oil. It is not necessary that these lines be cleaned since the amount of crude oil adhering to the walls of the pipe will be negligible. * * *

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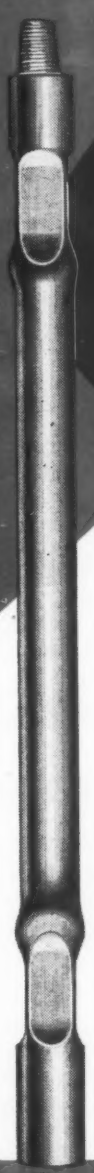

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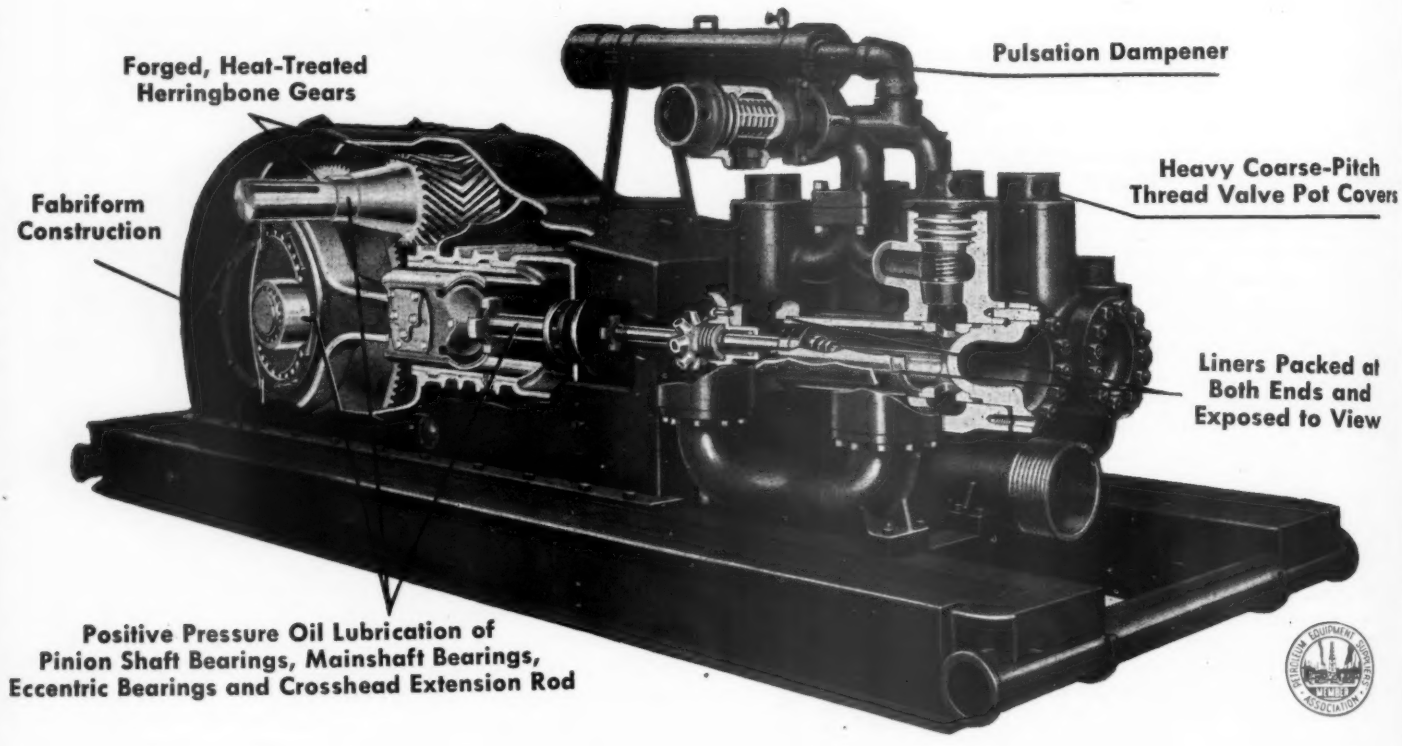
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Comparison of Casing Landing Methods

Potential tubular material failures may be eliminated through proper selection of landing method after cementing

J. W. PERET

THIS review of casing landing practices was thought appropriate in view of increasing setting depths of long intermediate and production strings characteristic of many programs now in use. As a result of this study, it is believed that the method of landing casing in full tension of its own weight without pullup or slackoff, relative to its condition at time of cementing, is the most satisfactory landing method. It is further believed that this method of landing, As Cemented, although not faultless, offers a minimum of deficiencies coupled with a maximum of advantages, to a degree well in advance of any of the other landing methods.

Landing Methods. The existing landing methods that have been used are listed below:

1. The casing is landed with a weight that is a certain arbitrary chosen percentage: (A) in excess of, or (B) less than, the measured weight of the pipe just prior to cementing.
2. The casing is landed at the exact position it occupied while cemented.
3. The casing is landed with a certain number of inches: (A) stretch, or (B) slackoff, per 1000 ft of casing length, measured from the free hanging position while standing cemented.

These methods may be briefed as Pullup (1A and 3A), As Cemented (2), and Slackoff (1B and 3B).

The acting stresses imposed upon casing during completion operations and the well's functional life are in nature, longitudinal tension, collapse or transverse compression, internal burst, tendency to buckle, and longitudinal compression. The latter is important insofar as it causes the buckling tendency. Because some stresses always act in unison combined stresses are also produced.

Change of Magnitude in Acting Stresses. Assume a casing string landed by any one of the three general methods. Initially, before drilling the plug, acting stresses prevail of a certain magnitude.

The Author

J. W. Peret, petroleum engineer with the Sun Oil Company at Dallas, Texas, has been with that company since 1945. He studied mining at the University of Idaho, graduating in 1939 with a BS degree. After receiving his degree he worked a year for the Bunker Hill-Sullivan Mining and Smelting Company. He then went into the Air Force, serving overseas in Africa and Europe.

Then, to complete the well, many operations may be necessary. These operations change the magnitude of the acting stresses to a lower or higher value. Each condition or operation considered singly affects acting stresses, as shown in Table 1.

Resistant Strengths of Casing. Required performance of casing is to successfully resist all acting stresses; therefore, its resistant strengths must be adequate to perform this function in all of its multiplicity of applications, by not only balancing out acting stresses, but exceeding them by a safe margin. Through the use of safety factors, the operator uses this only means of building necessary safe margins into the casing string. The various operations of completion, swab down, acidize, squeeze, etc., and all operations of production, should never in any way be limited, restricted, nor barred, by inadequate resistant strengths of the casing.

Effects of Landing Method on Safe Margin. From the preceding, a general summary has been drawn of acting stresses; also the desired performance of casing, which is to provide resistant strengths to exceed all acting stresses by a safe margin. Next of interest is to investigate each of the three landing methods with respect to how they increase or decrease this safe margin. Given a casing string landed hypothetically by each of the three general landing methods, accompanied by a given series of completion and producing operations, substantial acting stresses will result. It is shown that the magnitude of the safe margin for each acting stress will vary, according to and directly dependent upon, each landing method. It is for this reason landing methods are of interest and important to the operator in the primary attempt to obtain miximum protective casing performance. (See Table 2).

Acting stresses and whatever associated magnitude they impart is an evil that is present and cannot be avoided in the overall objective of completion and use of the well; whereas landing methods may be varied at will and each under varying conditions and operations. Conversely each landing method

TABLE 1.

Conditions and operations	Change in acting stresses: Tension loading	Collapse loading	Burst loading	Buckling tendency
1. Drop in average temperature	Increase	.....	.....	Decrease
2. Rise in average temperature	Decrease	.....	.....	Increase
3. Rise of internal pressure	Increase	.....	Increase	Increase
4. Drop of internal pressure	Decrease	.....	Decrease	Decrease
5. Rise of external pressure	Decrease	Increase	.....	Decrease
6. Drop of external pressure	Increase	Decrease	.....	Increase
7. Replacement of internal fluid by a heavier fluid	Increase	.....	Increase	Increase
8. Replacement of internal fluid by a lighter fluid	Decrease	.....	Decrease	Decrease
9. Replacement of external fluid by a heavier fluid	Decrease	Increase	.....	Decrease
10. Replacement of external fluid by a lighter fluid	Increase	Decrease	.....	Increase
11. Swab down	Decrease	.....	Decrease	Decrease

Note: Above pressure changes (3—6 incl.) can arise from BHP, hydrostatic pressure, pump pressure in acidizing, squeeze, fractures, etc., gas injection, and water injection, etc.

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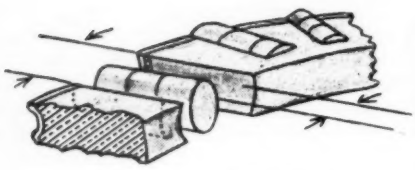

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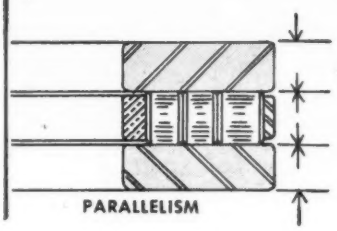

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method provides greatest safe margins provides least safe margins under other varying conditions and operations. This reasoning has led some to propound the idea of evaluating the conditions determining those acting stresses that will become major, their expected magnitudes, and calculating a landing method "tailored to fit" the specific major acting stresses for any given well.

At first glance this idea of a "tailored" landing method appears attractive; however, in actual practice it is absolutely impossible to enact intelligently by reason of the fact that much necessary landing information is always lacking and never known at landing time. Some landing information required to permit calculation of a "tailored" landing method follows:

1. Which acting stresses will be major.
2. Magnitude of major acting stresses.
3. Function of well—oil, gas, water injection, gas injection, and many combinations of duals.
4. Location of freeze point fixing casing.
5. Additionally, it is common for a well to change in function during its life.

In the case of wildcats, all five points of landing information are unknown at landing time. For field wells, No. 3 is always unknown until P & A; Nos. 1 and 2 are known only approximately and might vary greatly from well to well. The chance always exists that No. 4 may also vary among wells, even within the same field. The lack of landing information, in part or all, precludes calculation of a "tailored' landing method. Even to attempt such would be "a shot in the dark" and would be risky. Such practice might end accidentally in safe margins being reduced to least magnitude rather than being increased to greatest magnitude as desired. Inadvisability of chancing this risk of accumulative extremes is self-apparent. This then necessitates selection of one of the three general landing methods in the face of an absence of much desired landing information.

Analysis of General Landing Methods. Assume Pullup as the landing method used. If conditions and operations Nos. 1, 3, 6, 7, and 10 (Table 1) are major then considerable added tension will be imposed to the string by this landing method. With moderate tension safety factors, it is entirely possible the string will be undesirably overstressed. Another objection to this landmethod is that the increased biaxial loading reduces resistance to collapse causing need for heavier weights, higher grade with more expense in costs and tonnage. The case against Pullup is fairly apparent, its need almost never exists, and it is little used in the trade as a landing method.

Assume Slackoff as landing method used. If conditions and operations Nos. 2, 3, 6, 7, and 10 (Table 1) are major, then the tendency to buckle is materially increased by this landing method because these forces act in the direction to reduce tension or to produce compression. The slackoff of weight as directed by this method adds considerable compression to the string. These two compressions then add accumulatively to promote the buckling tendency. Buckling leads to failure by thread breakage especially in cavities or enlarged sections. Also restriction of tools may result if buckling becomes pronounced. For these reasons buckling is to be avoided.

Casing strings are slender columns and are governed by the laws of slender columns. Buckling can be prevented on slender columns by two methods:

1. Adequate horizontal bracing when loaded in compression. This can be provided only by hole walls; if washed to oversize diameters then this bracing action is absent.
2. Limiting compression or imposing at least minimum tension whichever applies, in accordance with the critical limits governing buckling for the nature of existing conditions.[1]

This then means Slackoff encourages, rather than prevents, the buckling tendency, and especially so where the free portion of pipe is quite long, and extensive cavitation exists. Where pipe is frozen in a near-continuous section from top of cement to shoe of next larger string, as frequently occurs on the Gulf Coast, much lateral bracing is afforded which counteracts the buckling tendency. To place complete confidence in, and place sole dependence upon, the

TABLE 2

Acting stress	Magnitude of safe margin where landing method is: Pullup	As cemented	Slackoff
A) Longitudinal tensile loading	Least	Intermediate	Greatest
(B) Collapse loading, or transverse compression	Least	Intermediate	Greatest*
(C) Burst loading	Greatest	Intermediate	Least*
(D) Buckling	Greatest	Intermediate	Least
(E) Longitudinal compression force	Greatest	Intermediate	Least

* Change here is small 5%±, and usually ignored in design calculations.

Explanation of Tabulation:

A — As the landing load is greatest and smallest, the safe margin in tension will be least and greatest respectively.

B & C — Shown by the "Ellipse of Biaxial Yield Stress or Maximum Shear-Strain Energy Diagram." (Shown in handbooks on tubular goods).

D — Buckling is caused by either excessive compression or insufficient tension. This is to say:
1. That for some conditions, buckling will not occur in the presence of some compression, provided the compressive stress does not exceed the critical limit.
2. That for other conditions, buckling will occur in the presence of some tension, where the tensile stres is less than the critical limit.[1] Therefore, the tendency to buckle will tend to diminish with increasing landing tension.

E — Longitudinal compression is mainly important insofar as it influences buckling.

[1] "Influence of Tension and Compression of Straightness and Buckling of Tubular Goods in Oil Wells," Arthur Lubinski, *API Proceedings*, 31st Annual Meeting, Chicago, November 5-8, 1951.

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prospects of continuous freeze and its hoped-for horizontal bracing action, however, is questionable.

• Tensile requirements in strings landed with Slackoff are the same as for those landed As Cemented; as adequate strength must be present to successfully run in the hole, and even though floated down, as soon as circulation is established, the weight of the string is then supported by the top joint.

• It has been believed that reduced tensile loading, after landing, across face of threads increases resistance to leakage. Subsequent work strongly indicates the reverse is true up to yield point.[2]

• Time was once thought to be a factor in causing tensile failure based on difficulties now understood to be "last engaged thread' breaks. These resulted from notch-fatigue caused by hammering of tool-joints, without rubber protectors, on the inside of uncemented sections of casing.[2]

In brief, Slackoff incurs dangers associated with the buckling tendency, and it is controversial in view of the above whether it contributes any real advantage.

Assume As Cemented as the landing method used. This method is intermediate, that is, the method neither increases nor decreases tensile loads and buckling tendency as compared to what existed immediately after cementing (See Table 2). This is *not* true of Pullup or Slackoff—the former increases tension; the latter increases buckling tendency. As Cemented offers the advantage of an intermediate position and affords a maximum of latitude to absorb increasing and decreasing stresses which will arise from future well conditions unknown at landing time. Its coverage to accommodate future unknown contingencies is greatest of the three methods. Additionally, it avoids accumulation of extremes, that is, it eliminates the possibility of the landing method imposing stresses that add directly and greatly, to well stresses.

In summary, a comparison of landing methods follows:

Pullup—Disadvantages:

1. Danger of excessive tensile stresses.
2. Reduction of collapse resistance by biaxial loading, causing higher costs, and greater tonnage through need for heavier weight and higher grade.

Advantages of Method—None

Need: This method would only be needed on very shallow wells producing very large volumes of very hot fluid. These conditions seldom if ever exist.

Slackoff—Disadvantages:

1. Adds considerably to the buckling tendency, which promotes thread breakage and may restrict tool passage.

Advantages of Method—None

Refrigeration is not likely to occur to the extent where tensile strengths require slackoff relative to the stresses existing at time of cementing.[2] It is assumed safety factor used for coupling pullout will be in the nature of 1.75.

As Cemented—Advantages:

1. Method itself does not add to, or detract from, tensile stress or buckling tendency existing at the time of cementing.
2. Provides maximum latitude to absorb *all* eventual acting stresses where direction of stress is unknown at the time of landing.
3. Avoids accumulation of extremes, that is, no additional stress emanates from the landing method to add directly to well stresses.

It is believed that the use of the As Cemented method of landing casing is preferable to either Pullup or Slackoff. Although not faultless, the As Cemented method offers a minimum of limitations and a maximum of advantages to a degree well in advance of any of the other methods. In addition, the ease of execution and freedom from "rule of thumb" procedures makes this method convenient for use by field personnel who are not primarily concerned with stress analysis calculations.

This analysis is intentionally of a qualitative rather than a quantitative nature, as imposed by the fact that landing information is never complete, may vary widely in range, and does not follow any established pattern. Calculations based on an assumed set of data would therefore have little more than academic value for purposes of this article. * * *

[2] "Some Observations on Casing Strain After Cementing," H. G. Texter, *Oil and Gas Journal*, April 8, 1948.

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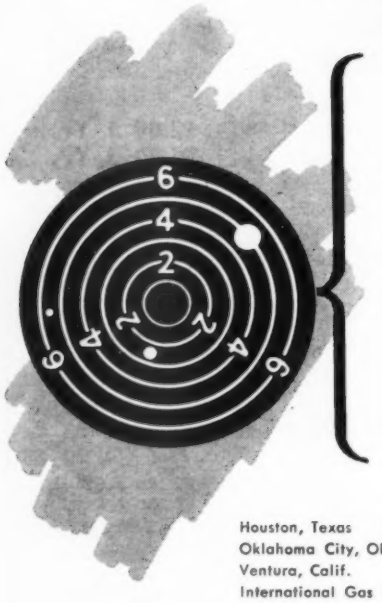

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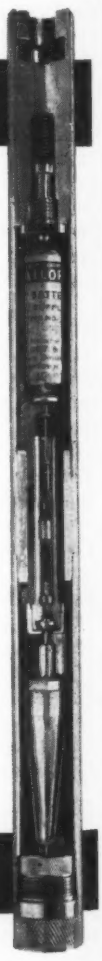

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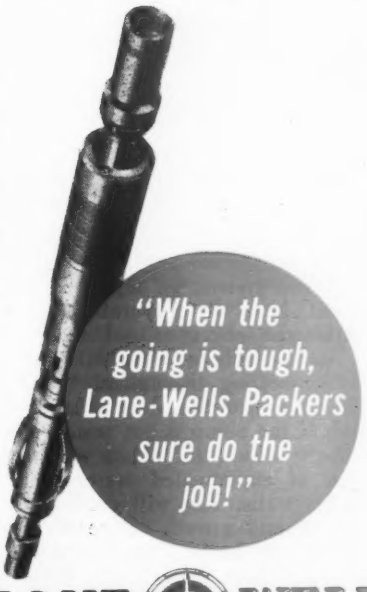

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AP-607

Cooling Rig Engines by

BOILING HEAT TRANSFER

Improved thermal efficiency with increased available power possible through steam cooling of internal combustion engines

O. B. FREEMAN

IN *The Petroleum Engineer*, 1953 Reference Annual, an article was printed on the subject of engine cooling by boiling heat transfer.

This paper dealt with the theories and laws governing cooling by latent heat of evaporation, thermal circulation, waste heat recovery, also mechanical and thermal efficiencies.

Because of the value of waste heat recovered in oil field production practices, principally for heating crude oil prior to dehydration and recirculation through hydraulic pumps, cooling by ebullition might be thought to have value to the production departments only.

As a result of the above, two erroneous ideas might have been conveyed.

First, that it would have little value on the drawworks and mud pumps of a drilling rig or well servicing unit.

Second that the waste heat recovered was the principal benefit to be gained.

We have consistantly found the mechanical benefits to be of much importance. These consist of increased horsepower, simplicity, reliability of operation and decreased maintenance costs. Waste heat recovery is definitely a by-product only and should be so considered when evaluating the economics of this type of cooling system installation.

Of course if this heat can be used, it is an added dividend and should be treated as such.

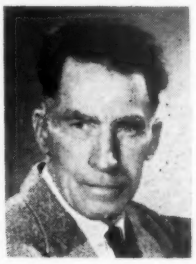
Boiling Heat Transfer Cooling

For those who may not be familiar with boiling heat transfer cooling, a brief explanation might be in order.

In this system, we depend entirely on latent heat of evaporation of water within the jackets to cool our engines.

As this calls for a condition of established boiling throughout the engine, the removal of the water pump is essential. If the pump is not removed, water velocity within the jackets will wash the film of superheated water from the jacket walls. This will prevent the formation and growth of steam bubbles. Result will be high temperature liquid phase cooling. Heat transfer from metal to water will be very slow. Metal temperatures will be elevated and detonating is expected under heavy loads.

The Author



O. B. Freeman entered the oil industry in California after his discharge from the Army at the end of World War I. At that time he began taking extension courses in mechanical engineering, later taking a year's leave of absence and attending the U. S. Aircraft Engineering School in Kansas City, Missouri, in order to get more mathematical training. He has spent eight years in extension work and residence engineering school, paying special attention to the study of heat.

He joined Tidewater Oil Company in 1935 as a compressor plant foreman and is currently in charge of plants and mechanical maintenance of the production department Coastal division.

With ebullitionary cooling, steam leaving the jackets carries with it considerable quantities of water.

Consequently, a small steam and water separator is installed just above the engine and at a convenient location in coolant outlet of engine.

Water leaves the bottom of the separator and returns to water inlet to cylinder jackets completing the cycle. The steam leaves the top of the separator and passes to a condenser or heat exchanger. Condensate gravitates or is pumped back into the coolant system.

No makeup water is required except in case of leaks, steam vented to air, or draining of jackets preparatory to major repairs.

Ebullitionary Cooling on Drilling and Well Servicing Engines

Early this year, we converted a tubing hoist to ebullitionary cooling. This unit is powered by two six cylinder, 2 cycle super charged diesel engines, the drawworks being designed to handle 12,000 ft of 2½-in. tubing.

EXCLUSIVE

Several reasons induced us to make this conversion. First, we needed all available power as this unit is used only on deep holes, which load the entire unit to its limit. Second, the unit has no rotary table, an hydraulic power swivel being used for drilling out plugs, bridges, milling, etc. It is necessary to keep the diesels running during these operations in order to raise and lower the string. Consequently, the engines stood idling hour after hour. Since any engine man knows that this the easiest possible way to abuse and wreck a diesel, it was no surprise to us that our maintenance cost was prohibitive.

We knew that by raising the temperature of these diesels above 212 F we could get cleaner combustion and less carbon.

Also being above the dew point at all times, we could eliminate water sludge and acids in the crankcase.

Another thought that influenced the change was that of occupational illness. On our spark plug and diesel jobs, the driller stands at the brake with little or no protection. Consequently, during the winter months, colds, flu and pneumonia is very prevalent among these men. We have also blamed "twist offs" and other mishaps to their lowered efficiency during inclement weather.

By going to boiling heat transfer we could install steam coils and give the driller the same protection he had with our old steam powered rigs.

On the steam rigs we have at times run a steam line up the derrick and installed coils for benefit of the derrickman. Probably the principal objection to this practice was those fellows were sometimes too lazy to keep joints tight in the lines.

Hot water leaked out and ran down the driller's neck. Trouble followed. With ebullitionary cooling it is perfectly feasible to heat the rig including the derrickman provided all joints are kept tight. Otherwise, it would be necessary to install an automatic water make up on the system. This would be simple, however. We do it on all our stationary installations.

Steam Separators. This subject is of special interest to the drilling operator as lack of space may dictate the type and shape of separator required. Sev-

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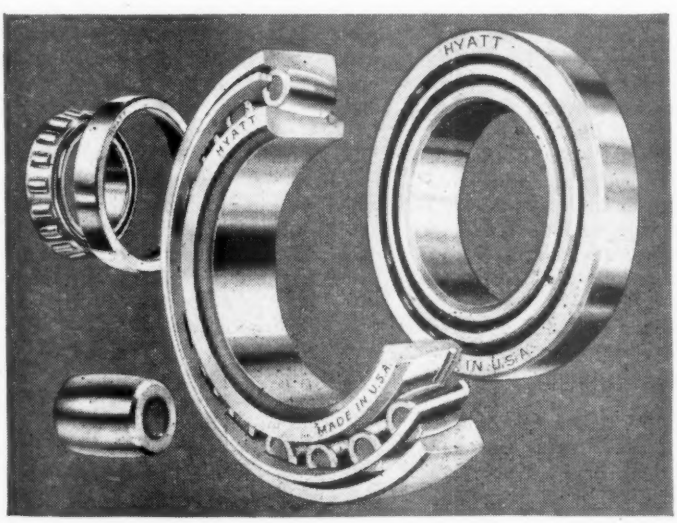

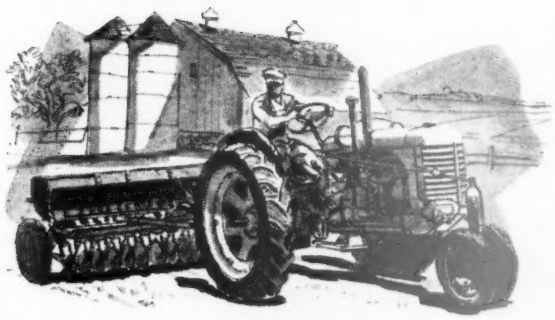

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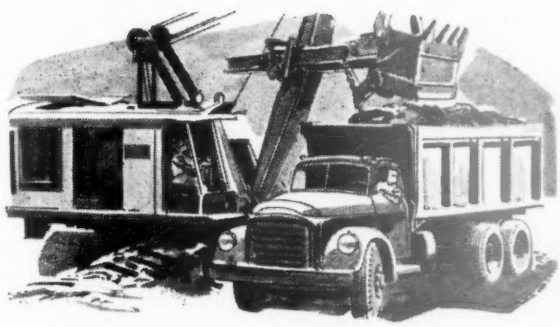

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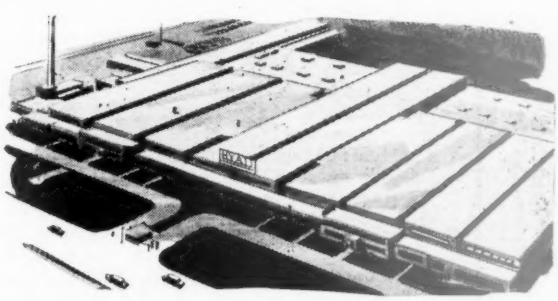

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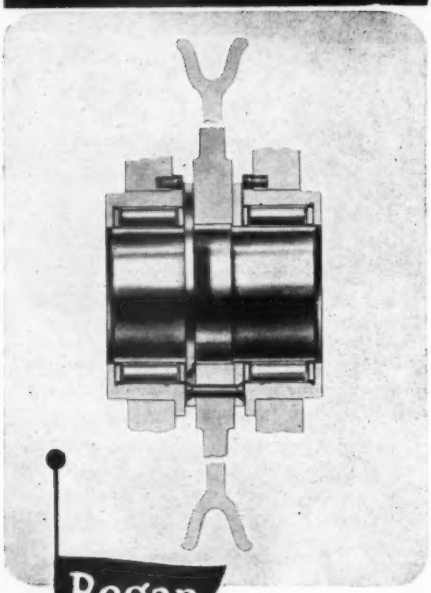

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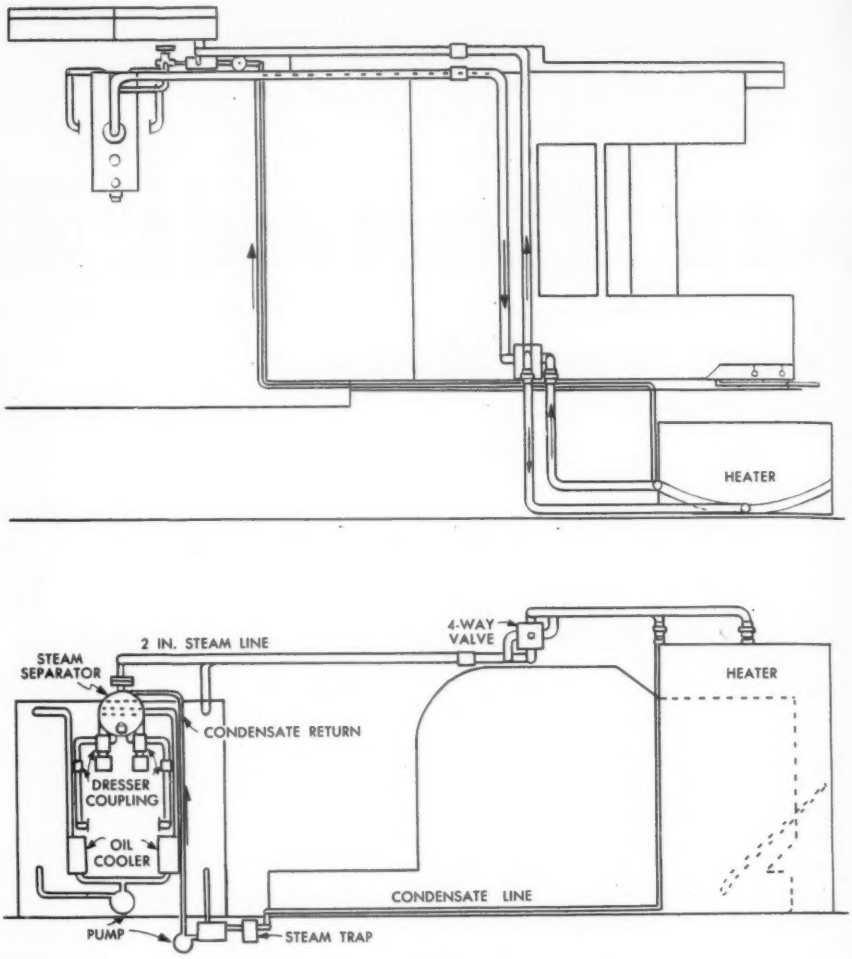

PIPING layout used for hoist engine ebullitionary cooling system.

eral types are currently being used. Some are vertical cylinders with tangential entrances. Others are boxes with baffles installed to effect steam and water separation. Still others are horizontal cylinders containing baffles.

On a small blitz rig or well servicing hoist where the mast folds back on top of the drawworks for moving, the horizontal cylinder most likely will be a must. There will usually be insufficient room between the engines and folded mast for a vertical or bulky separator.

We have seen the various types of separators in the fields separating water and gas. Efficiencies have been comparative in the various types. Since steam may be considered a perfect gas, these designs are all working satisfactorily separating steam and water on our engines.

Increase in Power. In this day of high drilling mud volumes, pressures and velocities, every drilling superintendent wants every pound of power available in his engine, and then he is frequently not satisfied. As a result, any additional horsepower we can put into these engines is gratefully received.

Very few people have made a study of engine metal temperatures or realize their importance in engine operation.

Consequently, it is hard for many to understand why merely changing the method of engine cooling should affect the available power in the engine.

This type of cooling, however, can and is influencing power out-put in internal combustion engines throughout the country today.

To elaborate still further, it should be remembered that higher temperatures within the firing chamber means cleaner burning with higher thermal efficiency and more power.

With conventional cooling, these conditions can not be achieved. Most operators de-rate their engines 10 per cent when working at temperatures between 200 F and boiling. This is necessary because of unevenness of metal temperatures. At these elevated coolant temperatures, hot spots develop causing detonation and loss of power.

Recently we made a study of metal temperatures in an 11-in. by 12-in. four cycle natural gas fueled engine cylinder cooled by water. Water enters this cylinder near the bottom of one point only, leaving through a single orifice near the top of the opposite side. A vertical row of thermocouples had been installed within the cylinder walls and offsetting the water inlet by a few inches.

Temperature readings showing a definite lack of uniformity was reflected in readings taken of the cylinder wall temperatures. These wall temperatures were not comparable with published reports of similar investigations of other makes and types of engines. Increasing and decreasing pump velocities influ-

enced temperature differentials between top and bottom of cylinder walls but apparently did little else.

A 90 deg angle jet was then placed inside the water inlet to this cylinder. This jet speeded up and deflected the water around the cylinder. Temperature recordings showed quite an improvement. Metal and water temperatures were much more uniform than when water was merely allowed to dump into the jacket.

As a result of these studies, we find it hard to conceive of a streamlined engine cylinder jacket for cooling by direct interfacial heat transfer.

Hot spots will inevitably develop and cause knocking and loss of power before a temperature elevation is reached which will give a maximum of thermal efficiency.

The test cylinder was then transferred to an engine being cooled by ebullition. Metal temperatures were surprisingly uniform. No indication of hot spots were apparent. From the bottom to middle of ring travel temperature differential was 6 to 7 F. At the top of ring travel, metal temperatures were about 12 F above center of the cylinder.

With this low differential, cylinder taper would be too small to cause flexing of piston rings.

These, together with lack of cylinder *distortion*, provide an engine with minimum blow-by under any operating condition.

The above discussion of metal temperatures may appear rather long winded. It is. But it is necessary if we are to stress the importance of uniformity of temperature and elevation of temperature in obtaining increase of horsepower.

No driller or drilling superintendent will question the value of these added horses to his drawworks and mud pumps.

Ebullitionary Cooling Installation on Drawworks

The engineer in drawing plans for boiling heat transfer cooling on a drilling rig, or any other equipment for that matter, should keep three rules in mind. They are:

1. Keep it simple.
2. Keep it more simple.
3. Keep it still more simple.

This type of cooling is one of the simplest things imaginable. Nature does the major part of the work for you. So keep it simple and let her work. When the designer starts getting fancy, he definitely starts leading with his chin.

Fig. 1 is a piping layout of an ebullitionary cooling system on a portable drawworks with folding mast. Engines used are twin 6 GMC diesels. One engine radiator is used as a steam condenser dissipating heat from both engines. This is made possible because of the high differential between steam and ambiant air. The other engine radiator cools the torque converter oil and crankcase oil.

As this radiator is considerably larger than those commonly provided for torque converter cooling, the oil in this converter runs much cooler than in any of our other rigs.

An end view of the water and steam separator is shown. It is a horizontal cylinder placed just above and between the two engines. It was necessary to use this type separator and place it as low as possible in order to clear the mast when folded.

Water legs are shown leaving either side of the separator and connecting with water inlet at bottom of the two engines. A tank type heater is shown installed at driller's back.

A 2-in. steam line goes from top of separator to a 4-way valve adjacent to the brake. From this valve, one line goes to heater and another goes to condensing radiator.

Direction of flow being controlled by this valve depending on whether the driller wants heat at the brake or not.

Half inch condensate lines return condensate from bottom of heater and condensing radiator to a small condensate receiver under the radiator.

A small turbine type pump picks up the condensate and returns it to coolant system.

As these engines use a combination lube oil and torque converter oil heat exchanger cooler, another turbine type pump circulates water through this exchanger and its radiator. Each of these pumps is driven off front end of the diesel crankshafts.

These engines generate about 1½ lb of steam per BHP hour when pulling.

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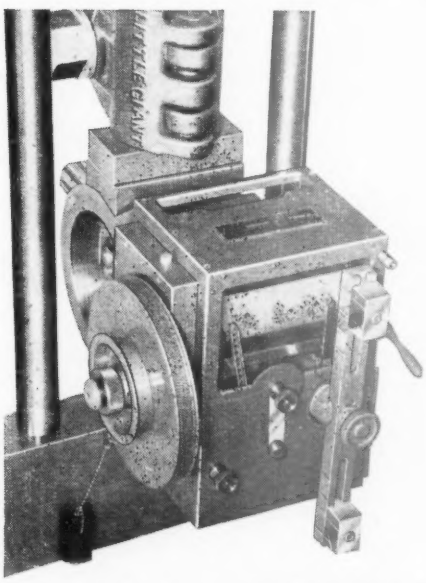

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When idling, the cold super charging air plus radiation from blocks and heads accounts for all waste heat from engine coolant. Accordingly, the driller must keep his engines working or he does not keep himself warm.

In a rig using 4-cycle naturally aspirated diesels or Otto cycle engines, there should be sufficient steam to operate a heater at the brake under any idling conditions.

The amount of steam that can be obtained from engines with water jacketed exhaust manifolds will be approximately as follows:

2-cycle super charged diesels, 1¾ lb per BHP hr.

4-cycle naturally aspirated diesels 2 + lb per BHP hr.

Otto cycle engines, 3 + lb per BHP hr.

The above may be materially increased by installing waste heat boilers in the exhaust lines.

Pressures at which steam is carried in the jackets covers a fairly wide range. We have operated all the way from atmosphere to 27 lb pressure. Change in steam pressures and temperatures apparently has no effect on an engine either for better or worse. Strength of cylinder jackets would appear to be the controlling factor.

As a result, the designer, by installing a back pressure regulator on the steam line to the condenser, may obtain steam pressure desired within design limits of engine cylinder jackets.

Another type of steam condensing equipment may be used on the heavier drilling rigs. Working on deep holes, lightness and compactness may not be so important.

In this case one might desire to remove the engine radiators and substitute horizontal condensers with steam driven fans. This type condenser is currently being used on both drilling and production machinery.

Items favoring such installation are: 1. Possibly more rugged equipment. 2. Elimination of radiator fan on engines, allowing a slight increase in available engine power. 3. Elevation of condenser above engines. This allows condensate to gravitate back to cooling system, eliminating both condensate receiver and pump.

Unfavorable items are: 1. Higher first cost. 2. Considerable more piping is required resulting in higher installation cost. 3. Condensers are bulky, take up much needed room and are so much more equipment to be handled when moving to a new location. 4. Because of above, are entirely unsuitable on small rigs.

Climate

With the advent of drilling in the far north, climate is becoming a very important factor. With conventional cooling, normal operations in these northern countries is almost impossible.

With boiling heat transfer, the story is different. When you go above 212 F, temperature becomes a function of pressure, consequently, by holding a pressure on the cooling system engine temperatures will be the same, regardless of what part of the universe you may be operating.

The Northern operator will naturally desire to kill his engines occasionally without draining the coolant. In this case a mixture of 40 per cent water and 60 per cent glycol will protect the jackets to around 65 deg below zero.

Good engine cooling with this mixture will be obtained.

On an installation such as shown on the accompanying plate, this would not be sufficient.

Since no glycol would be evaporated, the condensate receiver and pump would contain water only. In this case alcohol should be included.

A suggested mixture would be 10-30-60. That is 10 per cent alcohol, 30 per cent water and 60 per cent glycol. Regarding crankcase oil, normal procedures would be followed. No corrections should be made because of high coolant temperatures.

Because of constant pressures and temperatures, ebullitionary cooling should give the northern operator engine performance more nearly approaching that of the temperate zone than any other presently known method of operation. The same will be true in Arabia or in the tropics.

Although cooling by boiling heat transfer is not a "cure all" it is showing itself to be a definite step forward in efficient common sense engine operation. * * *

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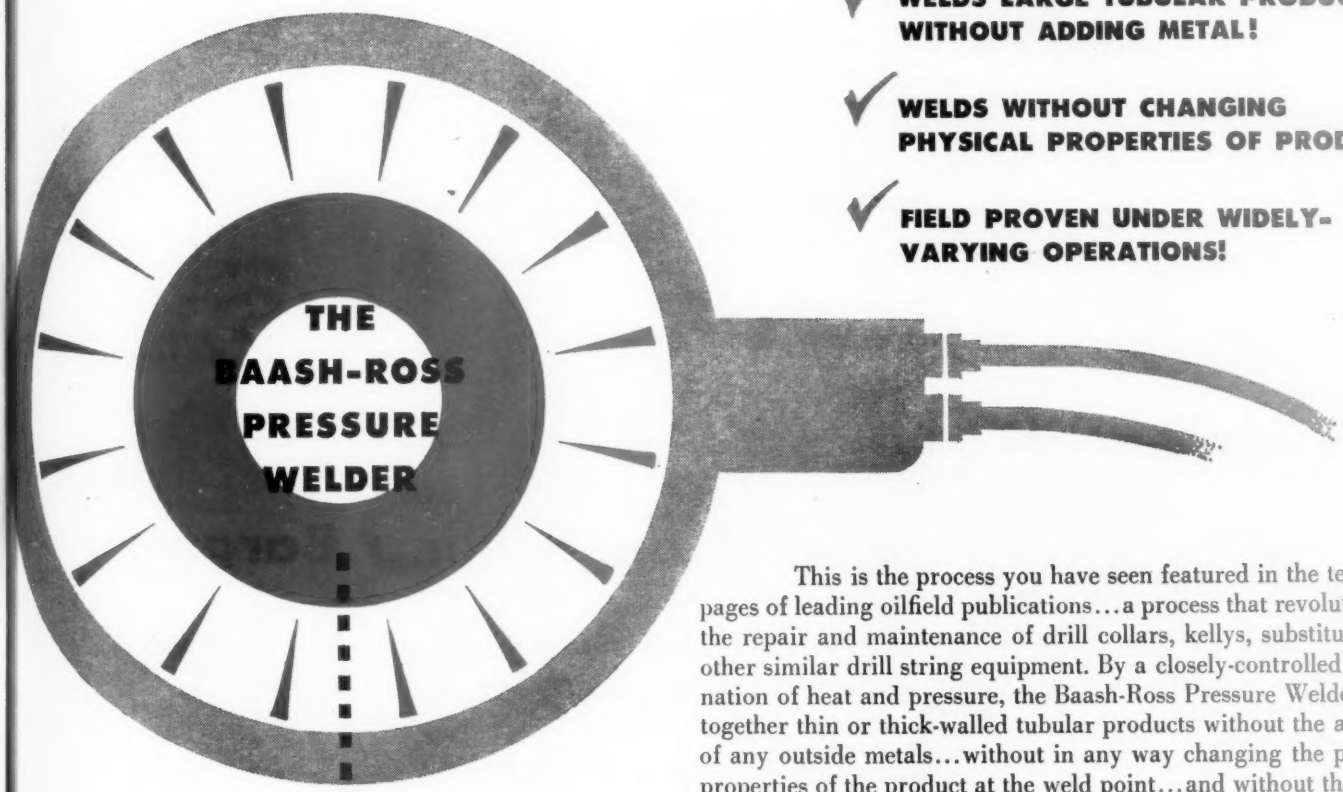

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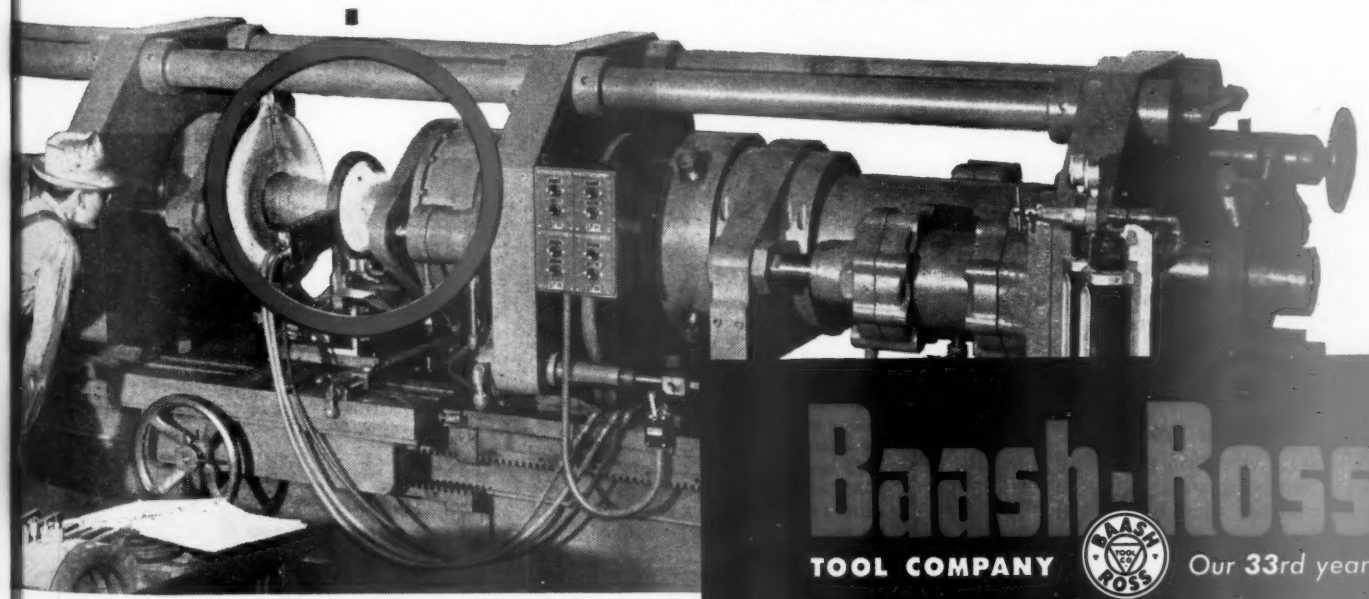

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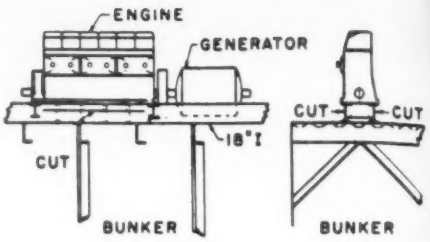


FIG. 2. LOCATION, upper right, of slot used to weaken engine support to lower vibrational frequency.

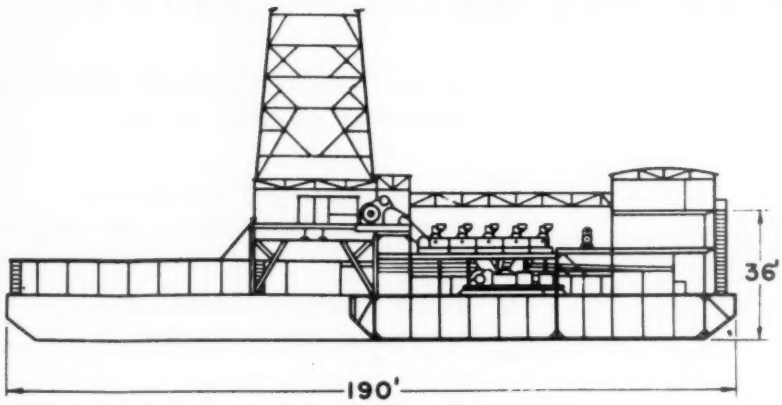


FIG. 1. TYPICAL barge structure sectioned through slot.

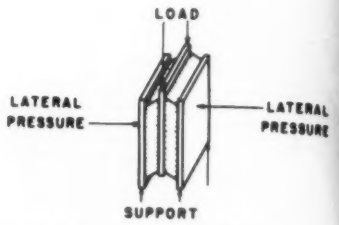


FIG. 3. BASIC rubber sandwich, two walls in shear.

Practical Approach to

Vibration Problems on Drilling Barges†

Rubber isolators and slight structural redesigns prove valuable in reduction of noise on offshore drilling rigs

T. B. HERNDON and A. B. REESE, JR.

Problems with personnel and equipment due to annoying and destructive vibrations on drilling barges in the Gulf Coast area have become increasingly acute in the past several years. The scarcity of experienced personnel, together with the use of costly drilling rigs with involved communication and accessory equipment, has made it imperative that operators give this matter high priority in the design of new barges and in the improvement of those already at work. As machinery manufacturers, the writers' company has had the opportunity of working with several operators and manufacturers to a successful solution of these mutual problems by means of vibration isolators.

The Problem

MINOR vibration problems have always existed to some extent on drilling rigs whether they be on land or on portable marine type structures such as drilling barges. As drilling barges became more elaborate and moved to more remote places, this problem began to approach a nuisance value. This is readily understood when one considers that the barge will have living quarters, complete corrugated metal housing and expensive communications equipment which might resonate and accentuate the problem.

The Authors

T. B. Herndon A. B. Reese

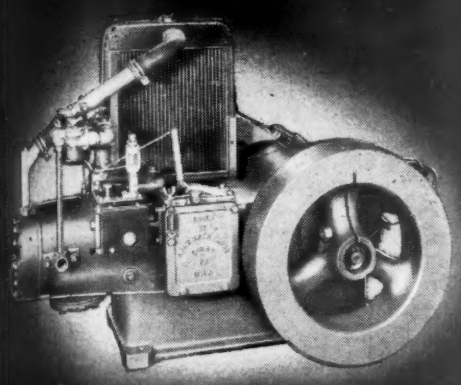
T. B. Herndon, as development engineer for National Supply, maintains a close liason between industry requirements and the company's product development program. He is a graduate mechanical engineer from Rice Institute, 1935 and came with National Supply in 1936. After that he served National in various technical and sales assignments. He was appointed to his present position in 1950.

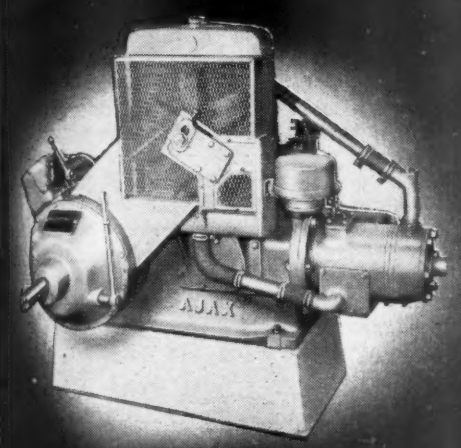
A. B. Reese, a graduate of Ohio State University in mechanical engineering, came with National Supply in 1935. In 1945 he was appointed assistant chief engineer in Springfield, Ohio. He was appointed regional sales manager for the engine division at Fort Worth in 1947 and in 1948 was made that division's chief oil field engineer.

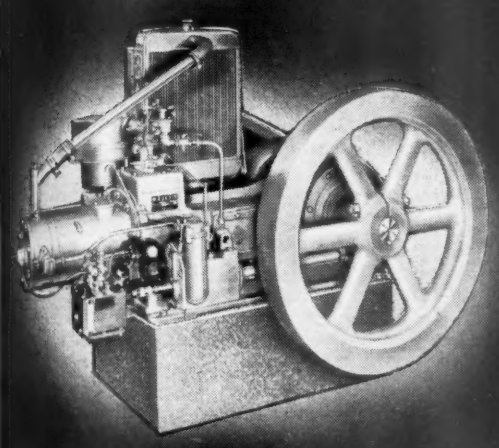
The consistent change of shifts on an eight-hour basis on land rigs materially reduces the fatigue factor of the personnel as compared to the barge operation. It is accepted practice for barge crews to live at their jobs by spending something like six days at location, followed by a six-day off period. The annoyance factor has reached the point where safety engineers have found it necessary to call a halt and insist on some remedial measures being accomplished. They have just cause in feeling that the continuous noise and vibration causes fatigue which might be dangerous to personal safety and property even though the man be relieved for twelve hours rest period in each twenty-four while on duty.

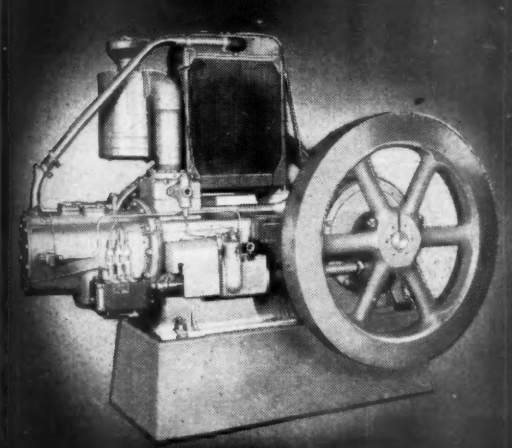
Fortunately, serious destruction of parts has been averted. There have been cases where radios have failed and the cause attributed to vibrations emanating from some machinery source on the barge as well as failures to piping and brackets that have been definitely attributed to continuous vibration.

An examination of the structure in Fig. 1 will disclose the cause of this problem. The structures are high to accommodate blowout preventers and accessory control equipment. At the same time, improvements in design of the structure have all tended toward the









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use of less steel and consequently larger spans with lower vibrational frequencies of the individual members. Added to this, the wide expanses of sheet metal housing present very good sounding boards and resonators for vibrations and noises. With the integrated type of barge structure, bulk head supports within the barge hull are lighter and spaced farther apart for the reason that in such integrated design the whole structure including the hull becomes a deep truss of great rigidity against breaking in two but with many members of widely varying frequencies.

This same structure will have mounted on it, in one form or another, machinery or vibration exciting sources which cover a generous frequency range. For example, slush pumps impart definite impulses to piping at frequencies as high as four times the pump speed. This usually results in vibrations from 50 to 60 to as high as 200 to 300 cycles per minute, and if one looks around the ordinary drilling barge he can usually find some pipe which is vibrating in resonance to some function of the slush pump speed and with considerable amplitude.

Medium and high frequencies can emanate from the drilling engines which range in speed from 450 to 1800 rpm and sometimes from some function of this speed, but most of the troubles experienced to date have been with normal rotative unbalance at engine speed. There have been cases of resonance at half engine speed in four-cycle engines with unusually heavy firing impulses in one cylinder or with one dead cylinder. Still lower beat frequency vibrations in multi-engine sets are very common. Higher frequency resonance of normal firing also occurs. The troubles experienced have not been due to shaft criticals for they are known and avoided in design.

There are still higher frequencies. Generator engines usually operate from 1800 to 2000 rpm and are multi-cylinder two-cycle units with many firing impulses in a minute. Shale shakers have high frequency exciting forces and roller chain tooth contacts are noticeable to some extent but mostly from the noise angle. Vibrations here are as high as 18,000 to 30,000 cycles per minute.

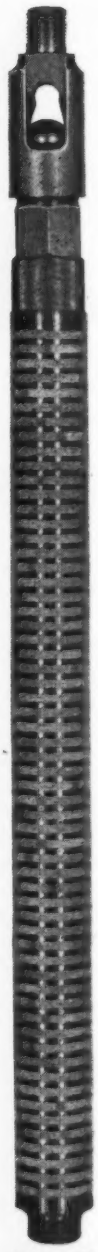
All of this adds up to the fact that a complex problem results when there is a wide range of exciting forces in the immediate vicinity of members having an equally wide or wider range of resonant frequencies without some insulating device being used between the two.

Solutions to the Problem

Earlier approaches to this problem frankly failed to recognize just how complex it was. Considerable time and effort was spent in measuring the frequencies of the troublesome members and of the exciting forces, and attempting to impart structural changes to the various sections which would simply take them out of the range of the forces causing the trouble. It is not difficult to imagine all the problems involved here.

Lateral and vertical vibrations were found in some of the members together with tuning fork effects of two engines operating within one span of beams. Some supports could be added, but it was quite difficult to find effecive support points over a bulk head for direct transmission through the barge structure to the bottom. If the support be placed in the middle of a deck plate, no benefit results. Lateral stiffeners to reduce unsupported spans, gusset plates and other means were tried with some effect and some satisfaction to the operators but were not a final acceptable solution in many cases. In other cases the members were actually made more flexible to put their natural frequency below the exciting force by removal of plates and by slotting of beams to change their modulus. This can be a dangerous procedure from a structural standpoint.

One interesting case of vibration elimination through structural change was accomplished on a diesel electric barge that had three supercharged eight-cylinder engines in the middle of the barge and two naturally aspirated sixes in line with the eights but on either end of the group and located near the edge of the barge. In fact, they were over fuel bunkers. One en-



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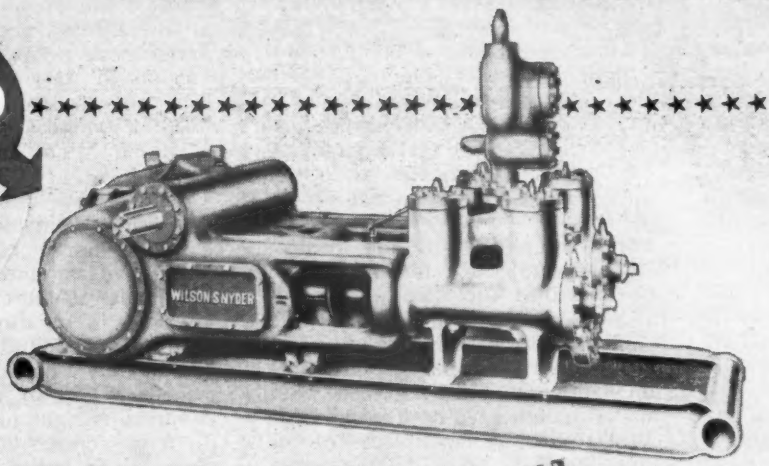

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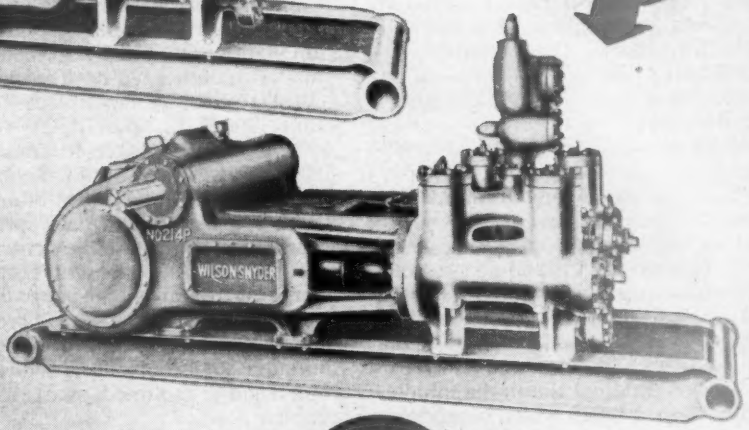

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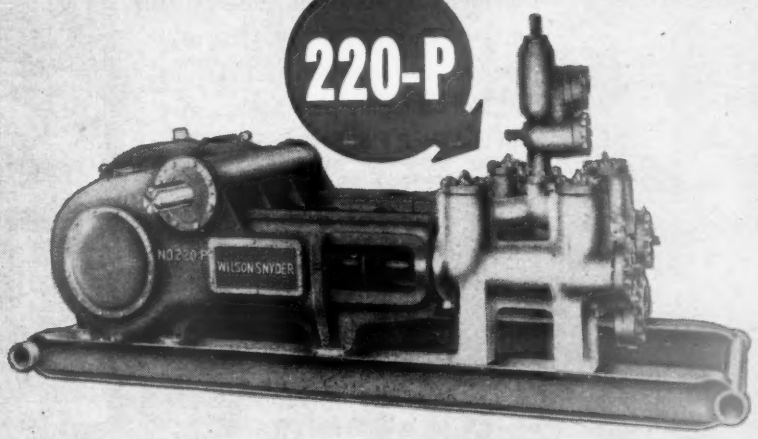

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gine excited a serious vibration at 750 rpm and a less serious one at 900 rpm while all the other mountings were quiet throughout the operating range. Raising the two frequencies by bracing sideways and also vertically inside the fuel bunkers which were directly below was contemplated. The next day the frequencies were checked again and it was found that the 750 vibration had moved up to 850 and the 900 disturbance had risen to about 1000. A discussion finally uncovered the fact that during the night a load of fuel oil had been delivered. It looked as though vertical bracing would have to be tried here, but degassing a fuel bunker was an expensive job and welding inside the bunker could not be risked without it.

Since this was a constant speed diesel generator set and only 900 rpm had to be cleared of vibrations, it looked as though this was a chance to lower a natural frequency by weakening the foundation. This could be done with a cutting torch without exposing the flame to the fuel fumes in the bunker.

The engine skid was weakened by cutting a longitudinal slot in the middle of each 18-in. I beam which composed the skid. The slot was cut 12-in. shorter than the length of the engine bed as shown in Fig. 2.

This method of reducing the stiffness of the foundation was satisfactory in that the serious vibration dropped from 850 to 800 rpm leaving 900 rpm clear.

Some further relief was obtained by preliminary design of the barge before selection of prime movers for the various classes of loads. But this approach has the disadvantage that a barge must be built for a particular set of machinery and success was not predictable.

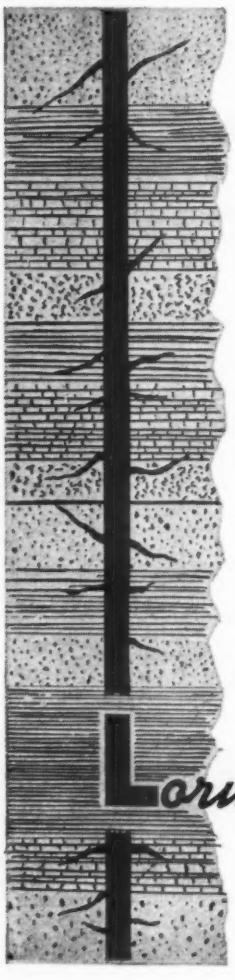
The complexity of the problem caused an approach toward isolating and absorbing the exciting forces at the source. Such a solution would mean that barge design would be independent of machinery from a vibration standpoint. There are cases where smaller masses have been installed adjacent to troublesome pieces of machinery and on mountings resonant with the exciting force to immediately absorb the energy of these vibrations before they were passed to other areas. There are also cases where spring isolators have been used extensively to free the machine mass to absorb the energy of excitation. The use of spring isolators presented some problems. Torque removal from a flexibly mounted engine of considerable rating to a rigidly mounted shaft was one problem.

The current and successful approach to the problem on drilling barges has been the use of rubber spring isolators. Steel coil spring mounts have been in use for many years, but they were not considered in these applications because of the possibility of transmitting high frequency noise vibrations to the large metal floor plates. Another objection to steel springs is that they can only absorb deflection in one direction, whereas rubber-in-shear can take it from any angle in the plane of shear.

The rotative unbalance of the various machines involved, even though it be quite small, can transmit forces through its mounting in a plane perpendicular to the crankshaft or rotating shaft in any direction. A compression type of mounting could efficiently handle only a portion of this. The rubber shear type of mounting in Fig. 3 mounted at right angles to the rotating shaft was chosen with deflection in a shear plane rather than compression, so that forces at the frequencies involved could be handled at any angle.

This choice presented the possibility of making quick experiments at low expense with stock mountings on two of the most serious offenders; namely, the drilling engines and the rig generators. Usually the slush pump vibration could be easily found and mechanically corrected and chain contacts are mostly a minor noise problem which can be treated separately.

In the isolation of the drilling engines, a simple bracket was designed to adapt existing frames to the mountings chosen. The type of installations are shown in the Figs. 4 through 8. A floating drive shaft with gear tooth



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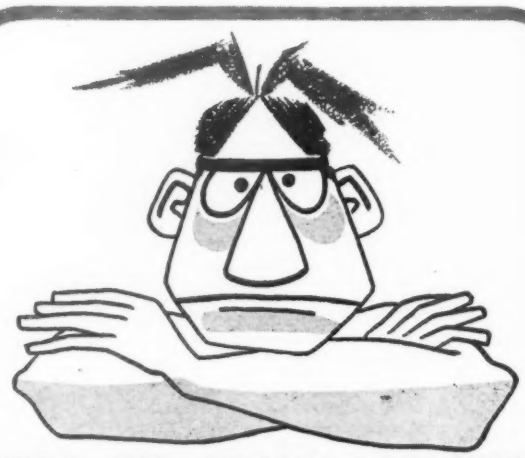

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couplings was used of sufficient length to provide for anticipated misalignment between an engine on flexible mountings and a shaft on rigid mountings.

The engines are mounted on rubber in such a way that they are free to move in any direction at right angles to the crankshaft by deflecting the rubber springs in shear only. Endwise motion is restricted by the mounts in compression.

To approximate requirements for rubber mounts, it is necessary to pick a natural frequency which will be one-half or one-third of the lower limit of speed range of the rotating or reciprocating machinery. The percentage of absorption versus the insulation ratio is shown graphically in Fig. 9. The insulation ratio is the ratio of the engine speed or vibrating frequency to the natural frequency of the mounts. For instance, if the engine speed is 600 rpm and the natural frequency of the mounting is chosen as 200 rpm, the insulation ratio is 600/200 or 3. The higher this ratio the greater the vibration absorption. When the ratio of the natural frequency of the unit to the vibration frequency is near unity, the vibration amplitude is increased many times. In other words, resonant frequencies should be avoided.

Having chosen the mounting frequency desired, reference to Fig. 10 will determine what static deflection corresponds to this frequency.

The manufacturer's curves on each style of mount will indicate the load in shear that each mount will support with this deflection. A typical curve is shown in Fig. 11.

After the load per mount is chosen, it is only necessary to use as many mounts as required to sustain the total load of the machine being installed. If too many are required, a larger size should be tried.

In cases experienced, a mount was chosen that would withstand one-eighth of the total load of the engines as only four double mounts could be used, one at each corner. Simple rubber-in-shear springs (Fig. 3) should be used in pairs so that a small amount of precompression can be applied to them before the shear load is imposed. This is done to preclude the possibility of excess tension in the rubber when the load is applied. This is accomplished by a properly applied pair of clamp bolts which can be removed after the heavy mounting brackets are securely anchored.

Generator engines were treated similarly but in this instance the entire engine generator unit skid was placed on commercial shear type mountings. The problem was quite simple as the generator operates at one speed and insulation ratios could be chosen for a high degree of satisfaction. Likewise, any

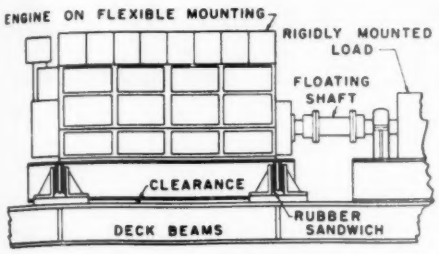

FIG. 4. DRILLING engine on rubber mounting.

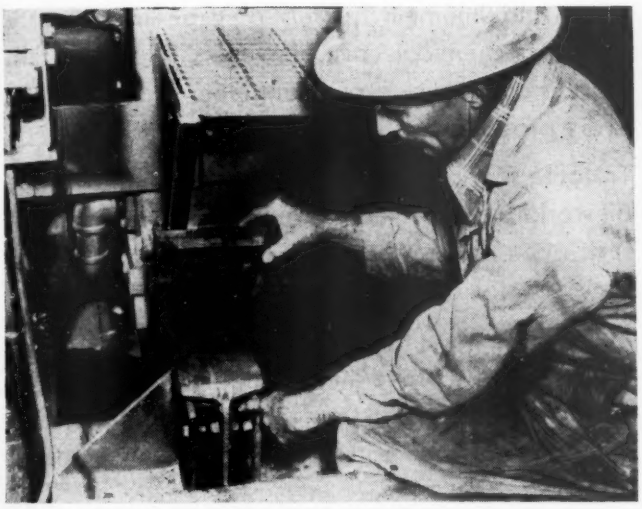

FIG. 5. ENGINE mounting within unit base.

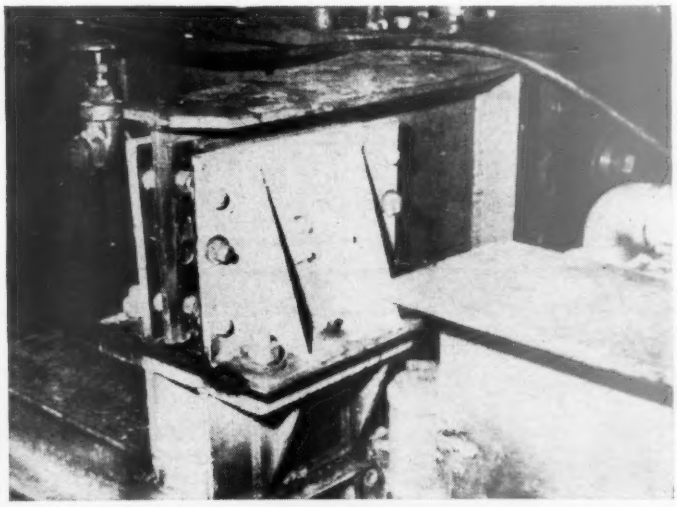

FIG. 6. ENGINE mounting for separate engine base.

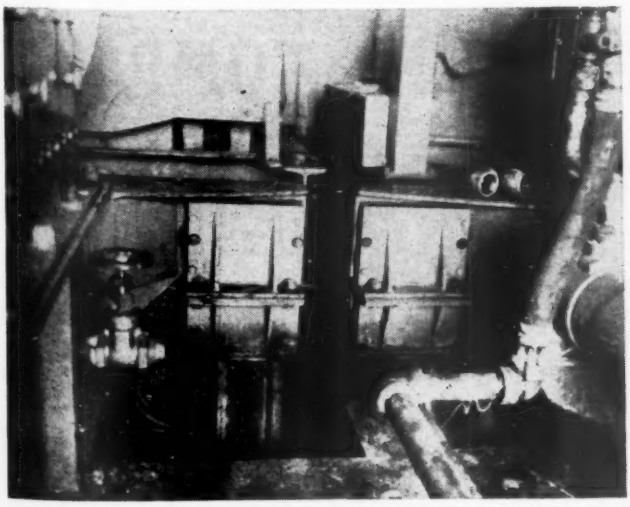

FIG. 7. SEPARATE BASE MOUNTINGS.

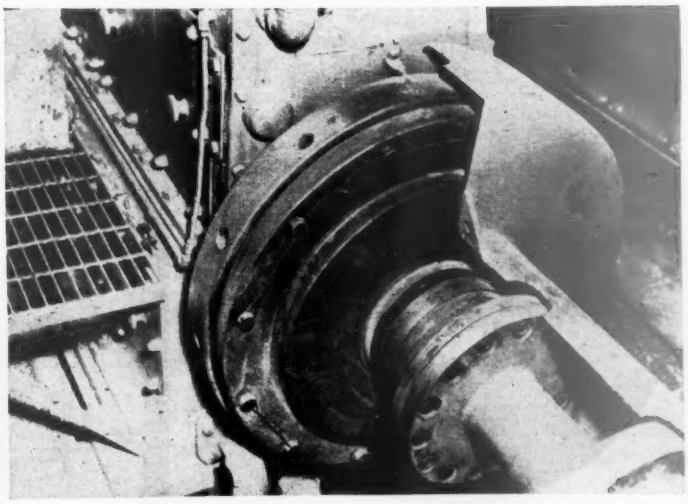

FIG. 8. FLOATING TRANSMISSION SHAFT.

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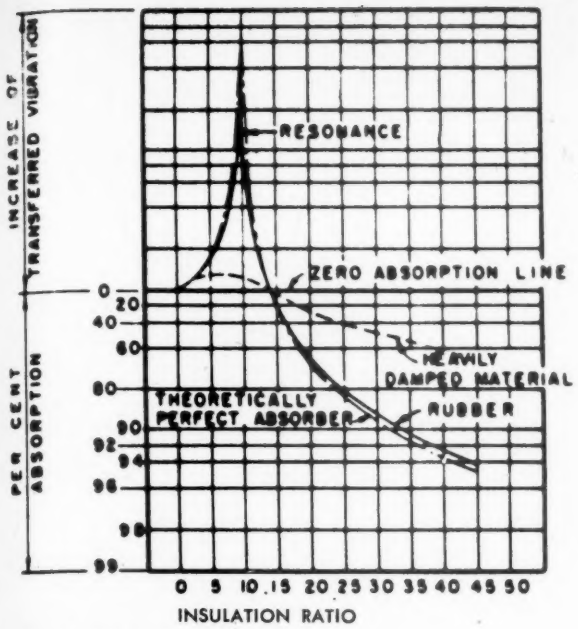
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FIG. 9. GRAPHICAL relation of absorption and insulation.

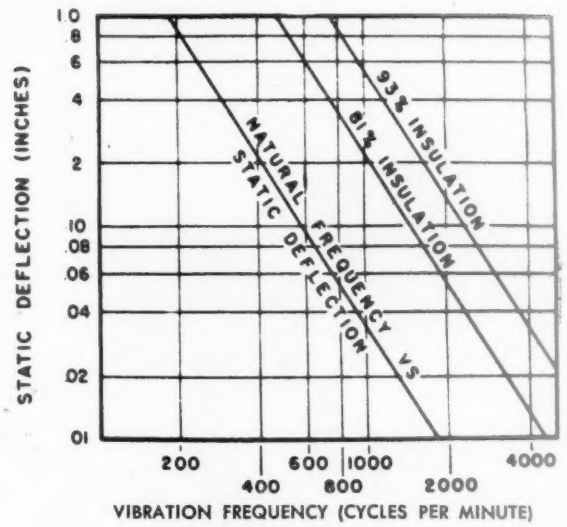

STATIC DEFLECTION (INCHES)
1.0 .8 .6 .4 .2 .10 .08 .06 .04 .02 .01
93% INSULATION
61% INSULATION
NATURAL FREQUENCY VS STATIC DEFLECTION
200 400 600 800 1000 2000 4000
VIBRATION FREQUENCY (CYCLES PER MINUTE)

FIG. 10. FREQUENCY vs static deflection.

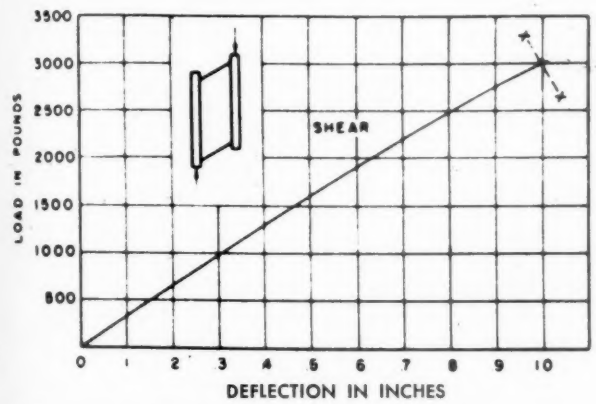


FIG. 11. LOAD-DEFLECTION characteristic mounting used on drilling engine.

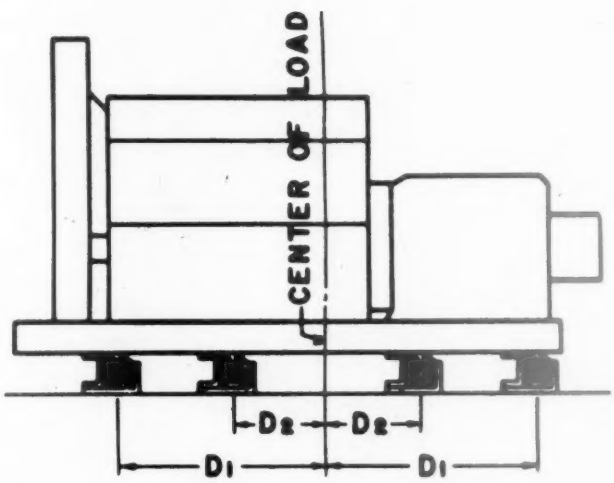


FIG. 12. ENGINE generator set on rubber mounting.

FIG. 13. MODE of vibration—Vertical. Frequencies—6 cyl.-272 CPM and 8 cyl.-200 CPM. Remarks: Large amplitude but out of operating range.

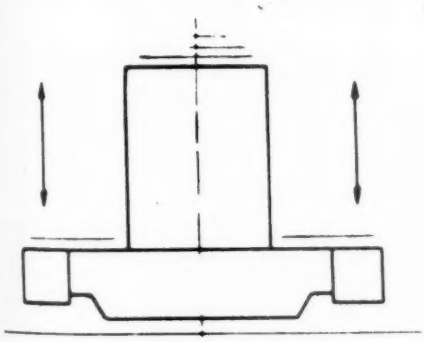
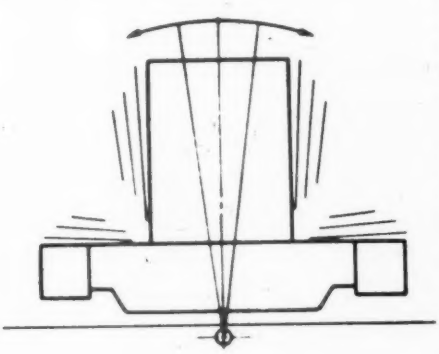


FIG. 14. MODE of vibration—Rocking. Frequencies—6 cyl.-156 CPM and 8 cyl.-112 CPM. Remarks: Large amplitude but out of operating range.

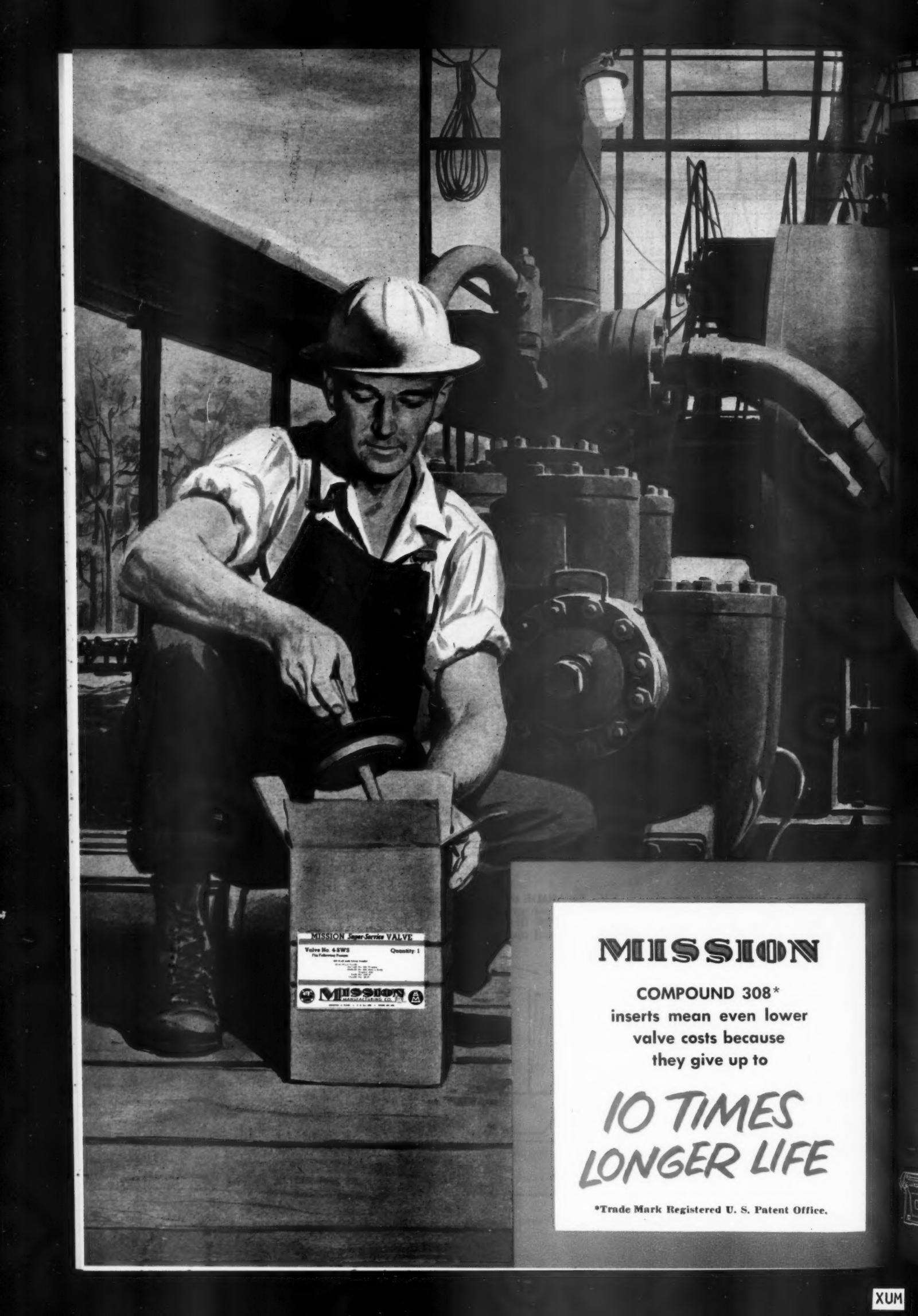


torque reactions remained within the skid. Fig. 12 illustrates this installation.

Results

In the cases most actively studied, the drilling engines were nominally rated at 900 rpm and operated at speeds usually from 600 to 900 rpm in the loaded condition and had idling speeds from 400 to 450 rpm. These engines perform quite similarly to that of an automobile engine which is mounted on rubber in that upon starting they quickly pass through a high amplitude low frequency resonant point with considerable shaking of a very short duration until they reach idling speed. At a speed between idling and normal operating range, there appears to be a low amplitude rotating frequency which is characteristic of the type of mounting. This was the only mode of vibration encountered in operating range and appears to be non-destructive.

Figs. 13 through 16 give the natural



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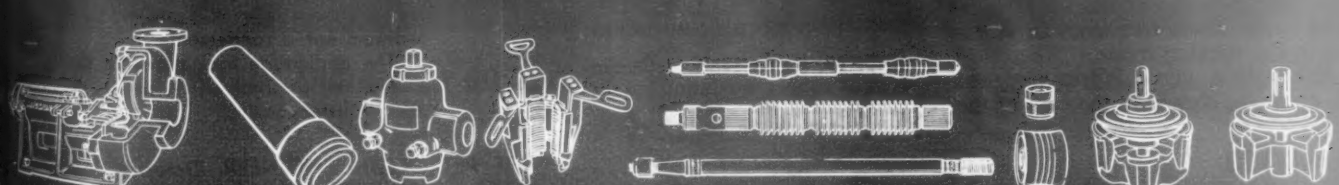

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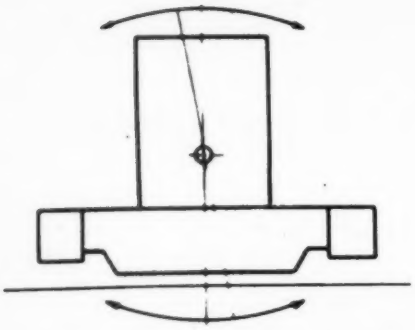

FIG. 15. MODE of vibration—Rotating. Frequencies—6 cl.-550 CPM and 8 cyl.-425 CPM. Remarks: Amplitude approximately 1/8 in. in 6 cyl. and 1/32 in. in 8 cyl. Measured at top of cylinder block.

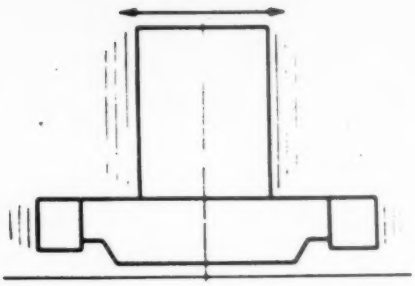

FIG. 16. MODE of vibration—Horizontal. Frequencies—Never excited but should correspond to those of vertical vibration.

frequencies and mode of vibration of engines thus mounted. All but the rotational mode were excited with the engine stopped simply by means of a pry bar with force applied at a speed that keeps the engine bouncing or rocking with little effort. Since the same rubber mounts were used with the six-cylinder and eight-cylinder engines, the natural frequencies for the two are different because of their weights which cause different static deflection. Static deflection is the amount the mounts sag when the engine is placed on them, and is a positive indication as to what the natural frequency will be.

Fig. 10 indicates that for any deflection of mounting there is a definite frequency at which a machine will vibrate if there is an exciting force applied to the machine in the proper direction at the proper frequency. This fundamental graph holds true whether the resilient foundation is rubber, steel, wood or concrete.

This chart gives accurate vibration frequencies for horizontal vibrations as well as vertical vibrations of the machine when all parts of the unit are moving in the same direction. In the case of rocking frequency and torsional or rotating frequency, the fundamental curve is useless. These modes of vibration are of a torsional nature and must be handled differently; instead of dealing with weight or mass alone, weight and its position with respect to the center of rotation or oscillation is the influencing factor.

Possibly this would be more clear if reference is made to Fig. 14 indicated as "rocking" mode of vibration. The center of rotation of the whole engine mass is a point below the base of the engine. In Fig. 15 indicated as "rotating" mode of vibration, the center of rotation of the whole engine mass is a point about a foot above the centerline of the crankshaft. The rotating inertia or WR^2 is greater in Fig. 14 because the distance R (radius) of each particle of weight is farther from the center of rotation than in Fig. 15. This difference in rotating inertia is indicated by the lower frequency of vibration in the rocking mode.

Although a vertical frequency of 272 cpm was chosen in the case of the six-cylinder engine, the rotating frequency occurred at 550 cpm. The spacing of the mounts about the center of rotation has a direct effect on the rocking and rotating frequency. If all the necessary rubber were placed at the centers of oscillation of the engine mass, the frequency would be very low and the amplitude high. Conversely, widely spaced mountings would result in high frequencies and low amplitudes. Optimum location for stability is based on structural and space limitations.

Rubber could be used in compression as a pad under the engine, but it would take a very thick pad of rubber in order to obtain the required static deflection. A pad of rubber loaded in shear will deflect some five times as much as it will in compression, (see Fig. 17). This is why it is advisable to load rubber in shear for such machinery mounts where the natural frequency must be held down.

There was obtained a noticeable reduction of the vibrations and noise in the entire barge structure. The use of the mounts seemed to isolate practically all noticeable vibrations and the little that is transmitted is far below the annoyance level.

Flexible exhaust and service lines still transmit some forces. It should be mentioned that along with this, certain things were done by operators to absorb air borne vibrations in the form of noise by acoustical treatment. This has much effect on the human evaluation of these results. It is a fact, however, that mechanically transmitted vibrations have been largely isolated.

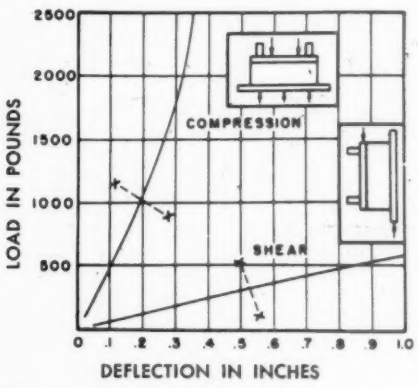

FIG. 17. RELATIVE deflection of a typical rubber mounting in shear and compression.

Conclusions

Isolation can be accomplished with excellent results and at comparatively small expense. In view of the fact that the first mounts have now been operating well in excess of one year under the normal drilling rig conditions, more than a sufficient economic life has already been achieved. Light metal covers and other treatments were put into effect to minimize the usually oily condition which exists around the drilling rig and under the similar circumstances in other industries where these rubber mounts are loaded to approximately the same degree they will operate from five to ten years without replacement. The cost of the original installation should be somewhat less than $1,200 per large engine and the cost of replacement should be in the neighborhood of $300 to $400. On this basis, if they give the kind of satisfaction already indicated for a period of two years, much has been accomplished.

In conclusion, this work should be carried on and extended into a more complete treatment of the vibration problem, particularly from the noise standpoint. There are now in use drilling barge structures relatively free of vibration and at least equipped with certain rest and relaxation areas where noise is held to less than an acceptable minimum.

Acknowledgments

Acknolwedgment is made to the following firms for their foresight and spirit of cooperation as well as the technical and material assistance they put into this mutual project: The Superior Oil Company, Richardson and Bass, United States Rubber Company, Levingston Shipbuilding Company, and The National Supply Company.

†Presented at the Petroleum Mechanical Engineering Conference of The American Society of Mechanical Engineers, Houston, Texas, September 28-30, 1953.

★ ★ ★

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Oil Monument Dedicated

Oil officially received a niche in North Dakota's history recently when the people of the state dedicated a monument to the new industry.

The unveiling of a memorial to recognize the discovery of oil at the Clarence Iverson farm, as a birth of the new state industry, highlighted the program. Governor Norman Brunsdale officiated at the dedicatory ceremonies.

In cooperation with the North Dakota Historical Society and the Greater North Dakota association, citizens from several western towns worked out arrangements.

The dedication took place at the site of the original oil descovery in the Williston Basin.

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Candid Shots from Ohio's Deep Test

1. DRILLING CREW: N. S. Woodside, J. B. Thorp, and D. O. Shrader, rotary helpers; N. C. Tuttle, derrickman; Fred Ryan, driller.

2. DRILLING CREW: Otis Roberson, rotary helper; S. R. Norton, rotary helper; V. R. Poehner, rotary helper; C. A. Craig, derrickman; W. T. White, driller.

3. DRILLING CREW: J. J. Helton, derrickman; Leroy Finley, W. E. McLaughlin, and A. McKay, rotary helpers; V. E. Gillett, driller.

4. DRILLING CREW: H. Tudor, daylight extra man; H. L. Patkoski, derrickman; Carl Mead, Bert L. Calhoun, and D. F. Young, rotary helpers; Frank Sherman, driller.

5. AMPLE space between gas engines gives Rotary Helper Bert Calhoun plenty of elbow room as he services engines.

6. DRILLER Frank Sherman stands at the controls of The Ohio's big rotary.

7. ENGINEER Frank Rieber inspects diamond bits used to take the Ohio well to record-breaking depth.

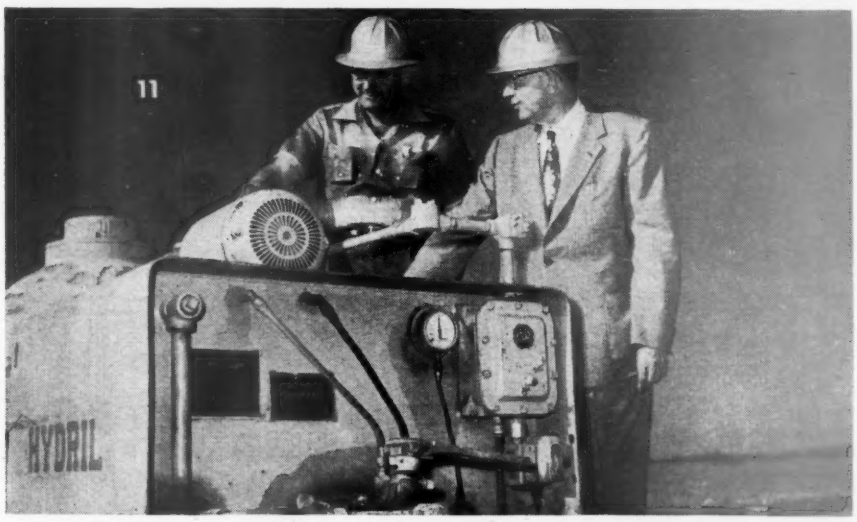
8. BOB DURHAM, tool-pusher, and Frank Sherman, driller, talk things over at The Ohio's deep Paloma well.

9. GEOLOGIST Tom Wilson inspects cores taken from The Ohio Oil Company's record-breaking deep well in the Paloma field.

10. AL SEAMAN, Oil Base, Inc., engineer; "Curly" Doane, Ohio Oil Drilling superintendent; Charlie Piskac, Oil Base, Inc. engineer stand beside the shale shaker. The Oil Base men were in daily attendance and supervised maintenance of the mud from time it replaced clay-water mud in hole (at 10,955 ft) to world's record depth.

11. WILLIAM T. KENNEDY division production superintendent and George Sowards division manager inspect accumulator for fluid pressure maintenance for hydraulically actuated blow-out preventor equipment.

12. ROTARY Helper Bill McLaughlin takes a sharp look at diamond bit pulled from 20,246 ft. Bit had been on bottom for 107½ hours, made 113 feet of hole.



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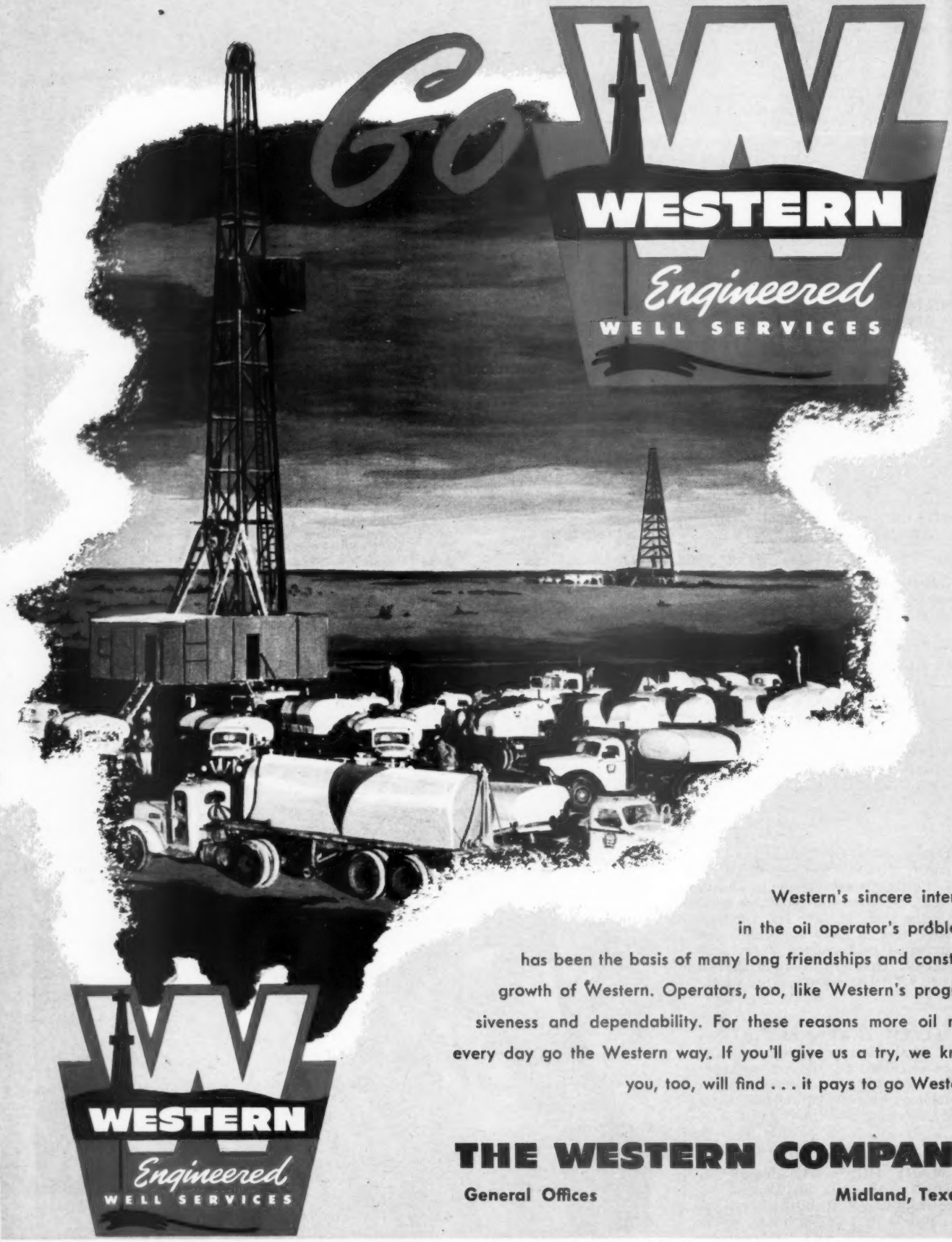

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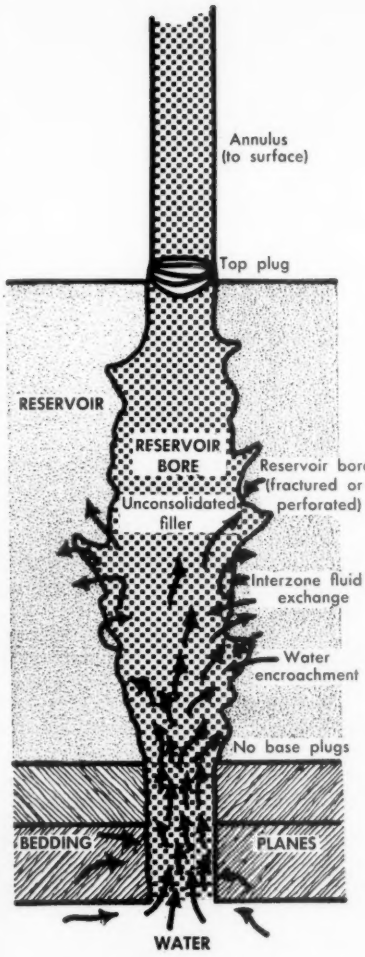
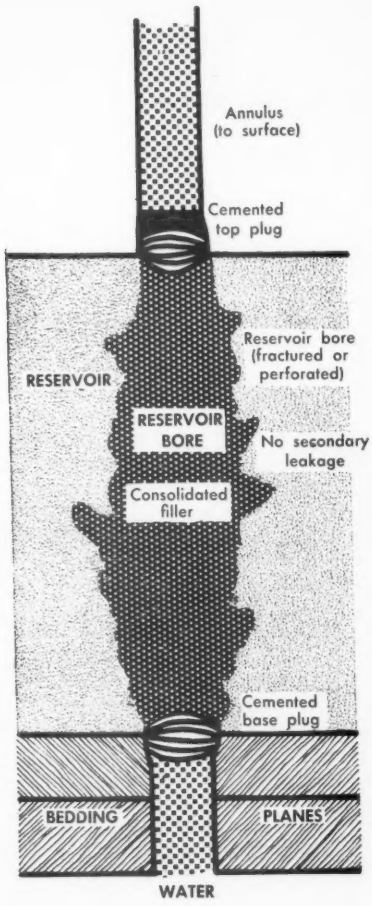


RESERVOIR bore closure with top plug and base filler.



RESERVOIR bore closure with top plug and base plug.

Base Plugs Essential in Sealing Abandonments

F. R. COZZENS*

Abandoned oil wells are generally plugged at the top of the reservoir, but seldom at the base. In lieu of base plugs, clay, or a similar filling material is introduced down the annulus and is brought into contact, almost invariably, with sloppy, emulsified residue remaining in the bottom of the bore. Emulsions saturate the filling agent, causing it to become spongy, and without an effective base-closure, the mass is made receptive to fluids and gases, pressured into it from beneath the reservoir. Eventually, vertical bore-pressures reach, and expand into the depleted zones of the former well, and a damaging water encroachment can occur despite the correct usage of plugs at the top of the reservoir. Vertical flooding is preventable by: (1) seating of tailored plugs at both top and base of an oil-pay formation; (2) using filler as a secondary sealing agent between plugs. Field-proved applications of these measures are described in the text.

*Equity Oil and Gas Company.

Defective Base Closures

OIL conservation efforts within recent years have brought into action a wide variety of laws, rules, and regulations, relative to the plugging of abandoned wells. Stipulations among these many measures differ considerably according to the geologic structure of an area, the type of wells, and their respective locations, but collectively, all pluging measures are focused upon one basic requirement, namely, that an abandoned well be filled from base to top with suitable materials, and that stable plugs of correct design and diameter be inserted wherever necessary to prevent encroachment of fluids and gases.

Because fluid, particularly water encroachment occurs most commonly through the top of the reservoir bore, it is mutually agreed that a stable plug is to be seated at that point. Unless the hole extends through coal or other mineral deposits, however, the use of additional plugs is generally optional with the pluggers who are not always familiar with the behavior of water, and are rather inclined to minimize the risk of a serious encroachment through the opening at the base of the bore. Consequently, a stable base plug is rarely inserted. The general contention is that the bore-base opening partially plugs itself by sedimentary deposits, drill-cuttings, etc., and it is assumed, entirely too often, that an effective base seal can be established by supplementing bottom-hole residue with clay, or some similar filling material. This theory can not be substantiated in field practice because (1) the bores of most wells extend through the oil-pay formation, and often for several feet into the bedding-planes, the bases are therefore subjected to pressures, which, normally, are greater below a reservoir than above it; (2) the bore bases commonly contain more or less sloppy residue, composed mainly of oil-water emulsions, including waxes, silt, gypsum, etc. Unlike separated water and oil, emulsified residue is not compact, but spongy, and a very few gallons are sufficient to impregnate several linear feet of any filling material that is introduced upon it, with the possible exception of cement. The resultant mass of saturated filler can be channeled by either water or gas, and in the absence of a stable base plug, little or no resistance is offered against the volume of water which is generally present within the base zones of the reservoir, or within its bedding planes.

There is sufficient field evidence to prove that base-pressures build up and become more intense after their normal release through the annulus has been banned by a plug at the top of the reservoir. Eventually, a break-through occurs at the bore-base, and water is pressured vertically into the column of filler. Since the reservoir bores of most wells have been enlarged, and the walls fractured, perforated, or otherwise disrupted by techniques for producing oil, there is ample space for water expansion. Ultimately, the base flood encroaches into pores, fissures, and crevices, which have been depleted of oil, and from thence to virgin areas of surrounding reservoir.

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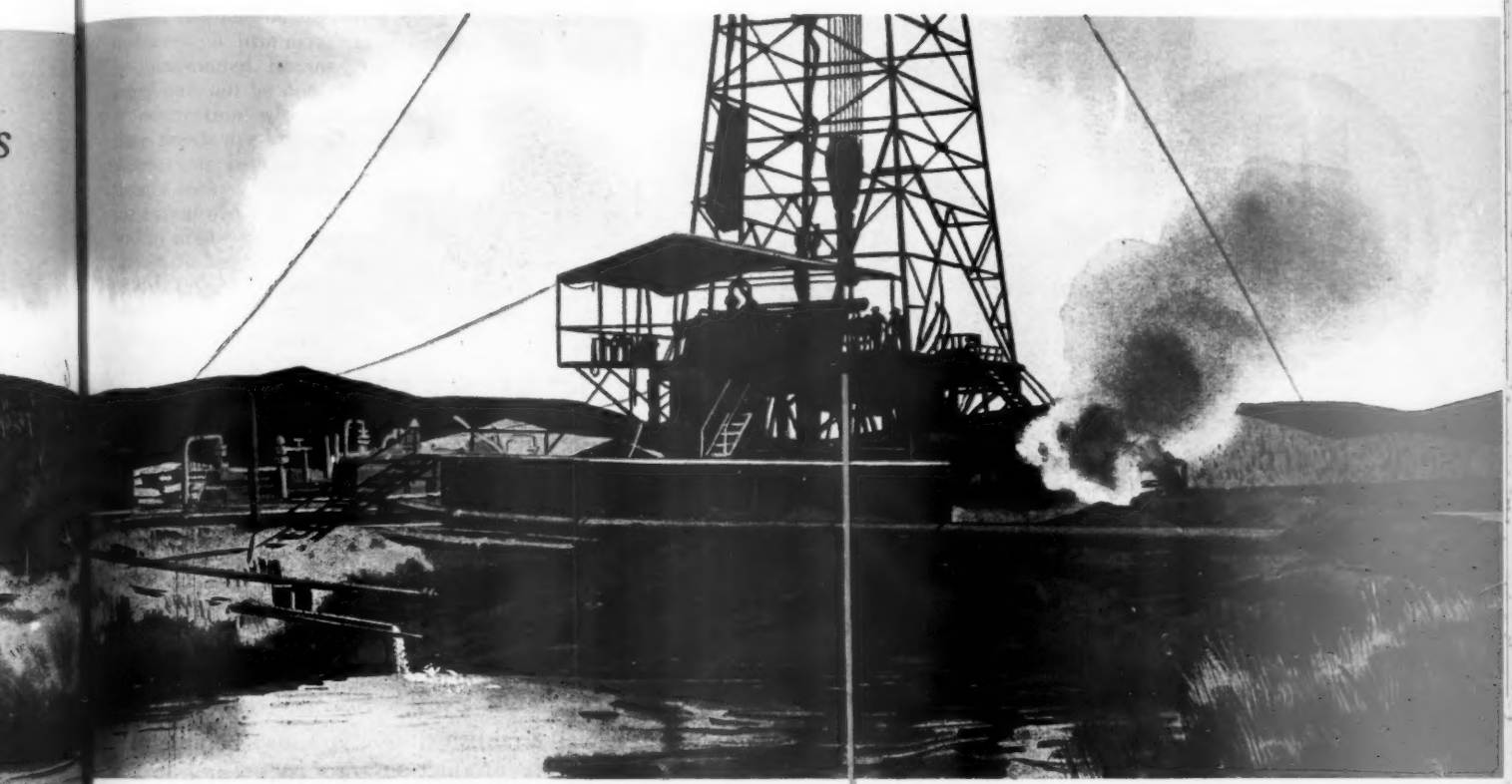

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abandonments often terminates the lives of nearby producers, but is most commonly revealed in new drillings, by watered-out zones of virgin pay, and by behavior of the water column which rises and falls from time to time in the bore. This latter characteristic is due mainly to intermittent break-throughs of pressures at a leaking abandonment, and is partly responsible for many of the floods being spotty, or having very irregular margins. Base water usually carries the colors of the bedding planes, varying from red to darkish-green, has a high mineral content, and often bears an obnoxious, stagnant odor. Infusion of the flood into scattered zones of the reservoir increases the difficulty of casing off the encroachment, and in many instances, a promising new well must be condemned because oil-productive zones can not be operated economically in connection with watered-out strata. Base floods are known to have damaged a reservoir beyond a radius of 600 ft from a leaky abandonment, and the major extent of water damage has occurred within areas where abandoned wells are known to have been plugged at the top of the reservoir, and the bores filled to the surface in accordance with prevailing rules and regulations.

Bore Conditioning

Base floods can neither be eradicated nor controlled through abandonments that were converted into leakers at the time of plugging. Further encroachment of water into a reservoir, however, can be curbed by eliminating former mistakes when plugging new, or additional abandonments within the area. Plugging measures must be applied according to reservoir structure, and it is equally necessary to proceed with practical knowledge, as to the type, and nature of the bedding-planes immediately below the reservoir, since the volume of base-water and its vertical pressures have a very definite bearing upon plugging techniques.

The reservoir bore of any spent producer or "duster" should be sealed as soon as the salvaging, or pipe-pulling rig is moved over the annulus, because a bailer or swab is a necessity, and either tool can then be operated by rig-power at nominal cost. Other necessary equipment includes: Steel measuring line and reel, a caliper rule (where bore-base diameters are unknown), an impression block (which can be fabricated on the job), and a spear for fishing out liners, broken pipe, or other obstacles which interfere with the seating of plugs. Plugs and filling agents are chosen after bore conditions have been determined.

Initially, the bailer or swab is run to the bottom of the annulus, and line measurements are checked with the drilling log (if available) to verify the linear footage of reservoir, and the approximate length of pockets, test corings, or any bore extensions which have been made below the reservoir. Some few wells are not drilled entirely through the reservoir, because of the known existence of base-water. In these in-

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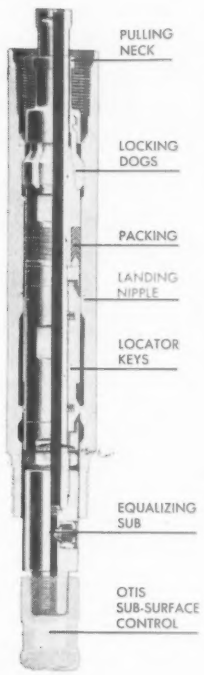

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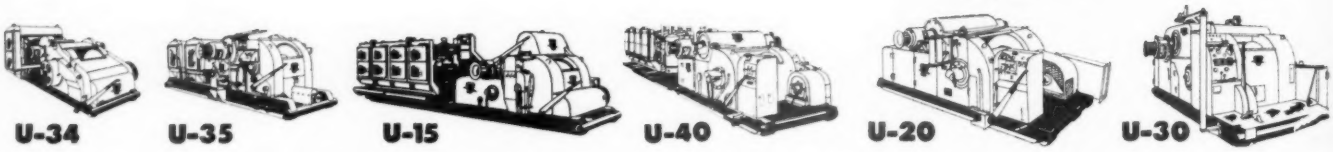

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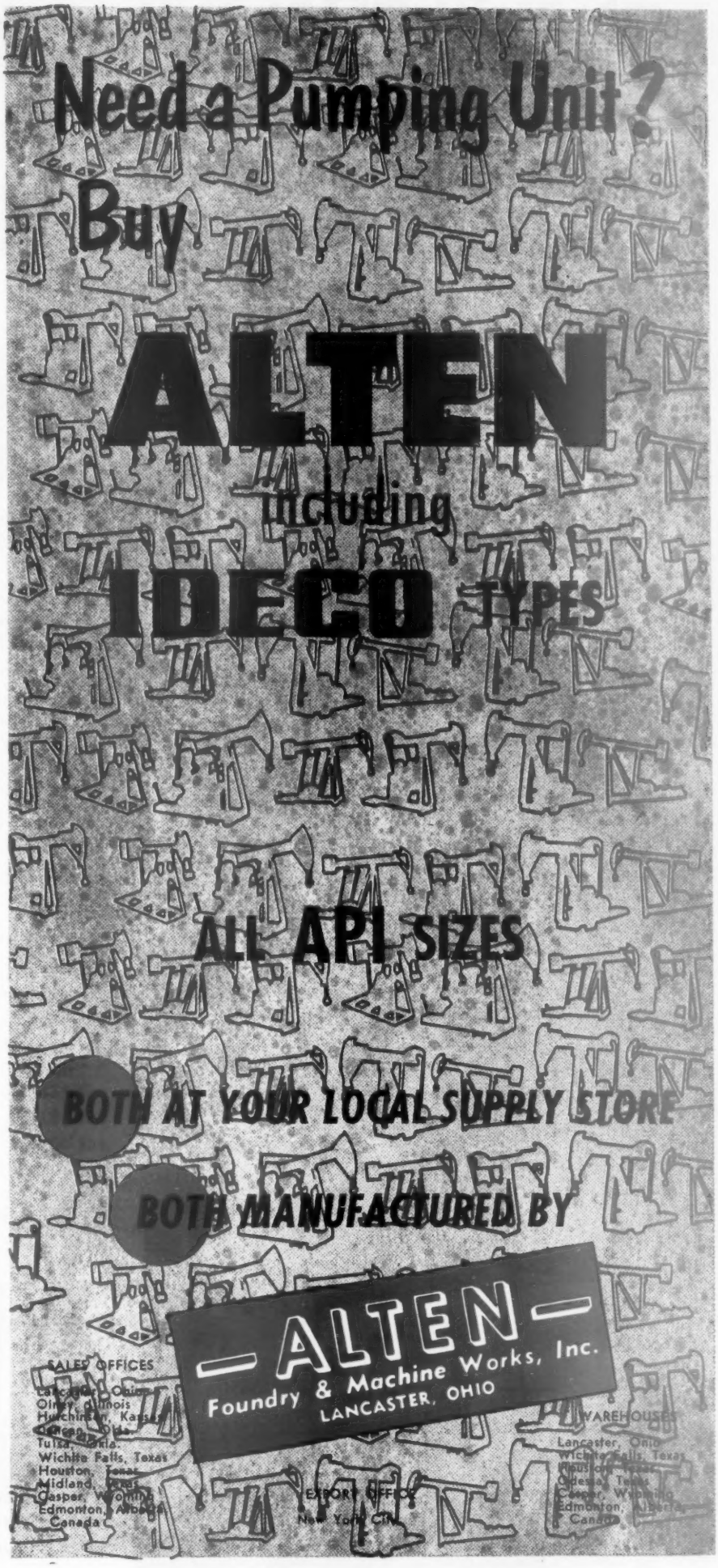
stances, the lowest horizon of bore is calipered, and otherwise prepared for plugging. Other wells have been deepened at some time, then plugged back to oil-pay horizons. Unless such plugging has been tamped, pressure tested, and backed-up with cement, a regulation or tailored plug is still necessary at the reservoir base. The great majority of wells at completion, or during work-over jobs, however, have been extended through the reservoir, and are provided with more or less pocket into the bedding planes. Where any such pockets or extensions exceed a depth of 25 ft, the most widely approved practice at abandonment is to place a temporary bridge acros the bore, 3 to 5 ft below the approximate base of the reservoir. The bridge is not intended to replace plugs, but to save labor and time in clearing the annulus. Shallow pockets or extensions can be filled to the designated position more economically by the use of cement slurry, preferably a gel-type which attains a quick, initial set in either water or oil. The objective in either procedure is to segregate emulsive residue so it can be bailed or swabbed from the bore.

Since stable plugs are to be seated in both base and top of the reservoir, the removal of emulsive residue from the intervening bore space between plugs might appear impractical and unnecessary. Base and top plugs, however, are designed solely to prevent encroachment INTO the reservoir. In checking back upon the well's history, we are remainded of the fact that secondary encroachments can, and often do occur WITHIN the reservoir, because depleted zones still retain some of their former pressures, and an interchange of fluids and gases among these zones can occur through the bore space between plugs unless prevented by a uniform, and tightly compacted mass of filling material. For permanent sealing, stable plugs must be supported by stable filler, and as previously stated, a filler that is impregnated with emulsions does not possess the required stability.

The adverse action of emulsions upon bore-filling materials can be visually demonstrated by mixing a gallon or so of emulsive residue (as taken from wells), with five gallons of pulverized clay, or similar filling agent. By saturation, the mixture becomes spongy. If emptied into a drum or barrel, and a hose is inserted through the mass to the base of the container, a low-pressured injection of either water or air will eventually cause water droplets or air bubbles to rise to the surface, proving its receptiveness to pressures. Similar action occurs in abandoned wells, where the filler is subjected to vertical, or secondary well-pressures. Necessity therefore, requires the removal of emulsions, and this can be accomplished, generally, at nominal cost by (1) drying the bores of normally depleted wells; (2) extracting emulsions from water columns which can not be bailed down, even though base pockets are bridged. This latter type of well is most commonly encoun-



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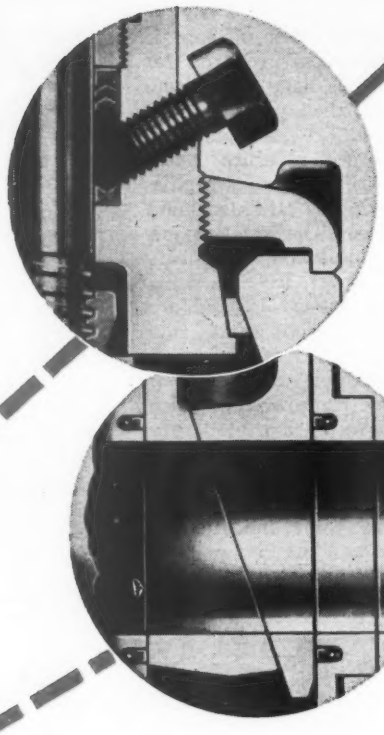

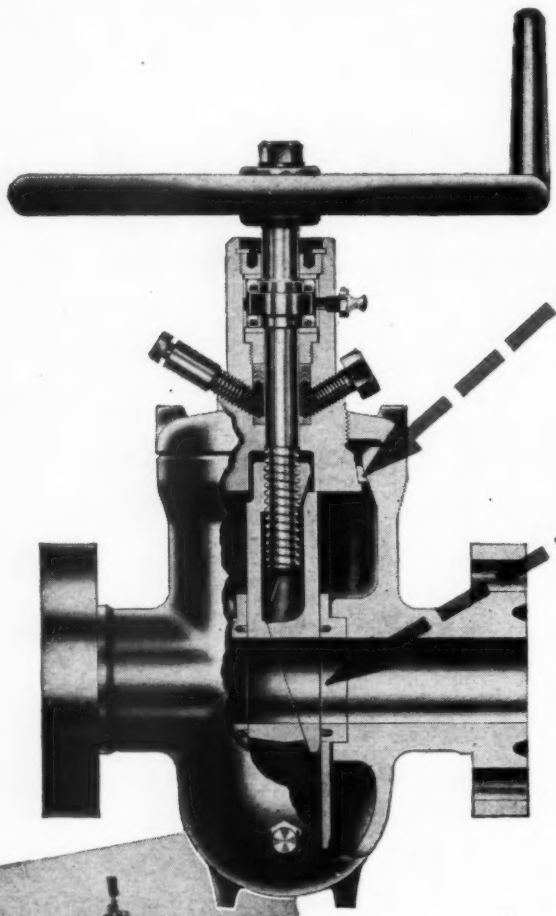

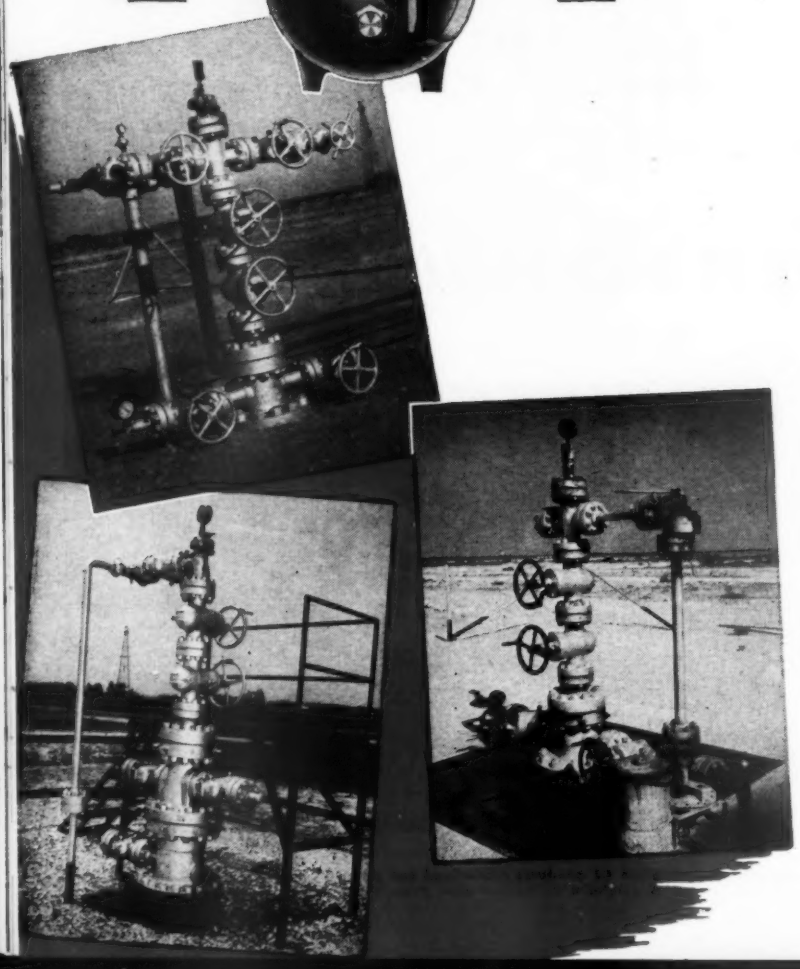

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W-K-M Valves

Eighty Percent of the World's High Pressure Wells are Controlled with W-K-M Valves

tered in reservoirs being flooded for oil recovery, or within reservoirs where considerable water is produced along with the oil. However, water of itself does not materially hinder the seating of plugs. The approved technique where stubborn water columns exist is to make the initial bailings or swabbings from the reservoir base, and the final withdrawals from the top of the water column. Both, base and top clearance is made necessary by the fact that emulsive residue disintegrates by agitation, and certain segments settle out of the water column while lighter fractions rise to the surface.

Wells in general, however, require no special techniques in clearing bores to the bridged, or cemented pockets, and the final procedure before plugging is to run the impression block to determine the contour of the base opening. From such outline, the required type of plugs is selected.

Plugs selected for base sealing are identical with those used in the top of the reservoir, except for a possible variation in diameters. They may be of metal, or dry, seasoned wood, spherical or tapered in design, with individual diameters slightly less than those of the bore-base opening. Spherical plugs are most approved for use in smooth, rigid, and well-rounded bore shoulders, particularly those of calcium formations. Tapered plugs are more favored for use in rough bores, having irregular margins, such as are common in sandstone or conglomerated reservoirs. Rocks, odd chunks of wood, metal, etc., should never be substituted for plugs.

Assuming that the bore-base position has been cleared of emulsive residue, bridged or cemented, the base plug of selected design and diameter, is dropped down the annulus. The plug is followed by bailer or weighted line to verify its proper location. Tapered plugs are tapped a few times with the weight of the tool to assure firm seating. After the tool is withdrawn, ten to twenty gallons of cement slurry, or a quantity sufficient to build a column of at least two feet over the plug, should be introduced, preferably by bailer. Bore filling begins as soon as the cement has attained its initial set.

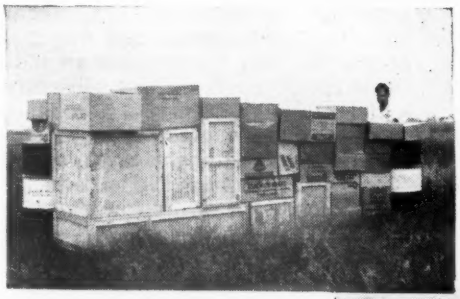
The filling agent (for reservoir bore) should consist of finely pulverized clay, compacted drill-cuttings (pulverized), or a mixture of rock sediment and cement, the usual formula being: 20 lb of rock sediment to each 1 lb of cement, mixed dry. Unless mining regulations, applicable to the area specify differently, the filling material should be wetted to the consistency of slurry, and introduced upon the cemented base-plug through a string of line-pipe, or by a small diameter dump-shell, 10 to 20 ft in length. Frequent use should be made of a tamping stick, attached to the line or bailer, and ample time allowed for the mass to settle into crevices and fissures along the reservoir walls. Water, which may rise in the annulus as the filler is applied, is of no consequence, and does not interfere with packing. When the column of filler extends to the top of the reservoir, or a few inches above it, a final settling period of one to three hours is allowed, to make certain that no cavity exists under the top plugging-shoulder. The top plug is then dropped, its seating position verified, and given a similar (10 to 20 gal) backing of cement slurry, as was applied over the base plug. When upper stretches of an annulus have extended through other oil or gas bearing strata, top and base plugging is again required.

Annulus space between reservoirs, or from reservoir to surface may be filled with coarser clays, road chat, or plain rock sediment. Extremely porous materials, however, such as cinders, gravel, etc., should never be used, nor should an annulus be bridged to save filling time. An abandonment can be considered completed when all necessary plugs are set, and the annulus is closed to its top with a continuous column of filling materials.

Summary

Since water encroachment can occur through either base or top of an oil-bearing formation, stable plugs are necessary at each horizon. Zonal interchange of fluids and gases between plugs should be prevented by a consolidated column of filling materials. By these basic measures, an abandonment is rendered impotent. The surrounding reservoir is protected, and less risks are involved when drilling new wells. * * *

WHEN Payload COUNTS...



The Otter

Actual photograph of a typical Otter cargo load. The Otter's cabin measures 16' x 4'6" x 4'6", or 345 cubic feet.

The extremely high cargo capacity of the Otter means appreciably LOWER ton-miles costs.

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2431 lbs.		300 miles
2181 lbs.		500 miles
1806 lbs.		800 miles

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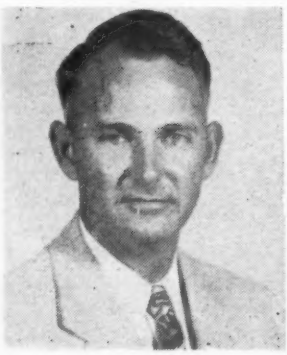
ALVIN BELANGER, Carl Johnson, Napoleon Kibodeaux, Mack Winters, and K. P. Parker are members of Stanolind crew that was awarded API's Accident Prevention Award.

Stanolind Crews Win API Safety Citation

Employees of Stanolind Drilling Rig No. 25 were warded the API's Accident Prevention Award in recognition of having worked 489,287 hours without a disabling injury. The citation covers the period between October 19, 1945 and December 31, 1952, inclusive. Between January 1 and August 1 of this year, Rig 25 compiled an additional 28,437 hours without a lost-time accident, giving the crew a total of 517,724 hours worked without a disabling injury. During this 8-year period 40 wells were drilled. Rig leads industry in number of injury-free hours.



H. H. Hunt

W. Kalteyer

W. L. Horner

Hunt Drilling Formed

A new drilling company, Hunt Drilling Company, Inc., has been organized by Hulen H. Hunt and Walter Kalteyer. The new company will office in the Wilson Building in Corpus Christi and will operate rotary rigs. Hunt, who will serve as president, is a graduate of Baylor University and served for 13 years as a scout with Gulf in South and East Texas. Kalteyer, who will serve as vice president and general manager, is an engineering graduate of the University of Texas and for eight years was an engineer with Humble Oil and Refining specializing in drilling equipment.

He was district petroleum engineer at Pleasanton, Texas, at the time of his resignation. Coy Pyle, for 10 years a tool pusher with Allen and Morris, drilling contractors, has been engaged as senior tool pusher for new company.

Sunray Sets Up Unitization Section

A new unitization project division will be incorporated into Sunray Oil Corporation's reservoir engineering department, and W. L. Horner, vice president and manager of the department, will be in charge of coordinating the formation of pool-wide conservation units.

Centralized direction of this work in the reservoir engineering and unitization department, through the planning, promotion, and actual unitization phases through the signing of agreements and approval by the proper state regulatory bodies, should enable Sunray to proceed rapidly with several proposed major secondary recovery and unitization projects. These conservation programs involve waterflooding, pressure regulation and injection, cycling, etc.

JIM HUGHES of Lane-Wells Company, president of Los Angeles Chapter of Nomads, introduces Frosty Martin, president of Long Beach board of harbor commissioners, at chapter meeting at Pacific Coast Club, August 12. To right is E. J. Amar, port manager of Long Beach Harbor Department.

AIME Plans Fall Meet

The Petroleum Branch of the AIME will hold its Fall Meeting in Dallas, October 19 to October 21, 1953. A wide coverage of the drilling and producing industry is anticipated, with papers on drilling operations, producing operations, reservoir mechanics, completion techniques, equipment, and secondary recovery scheduled. Of particular interest should be Tuesday's morning session on Economics and Management.

New Drilling Company Global in Scope

Drilling and Exploration, Inc., have teamed with Dutch interests in the formation of a new contract drilling company to operate initially in Europe and the Near East and eventually on a World wide basis. Name of the new concern is the Netherlands Drilling Company. Headquarters will be in Rotterdam and Monty R. Garrison of Washington, D. C., will be the managing director.

Shell Oil Establishes New Headquarters

The Shell Oil Company is establishing headquarters in Denver to better direct their operations in Colorado, Montana, Wyoming, North and South Dakota, the Nebraska panhandle, and the northeast quarter of New Mexico. The plans for the new office were disclosed by Shell vice president, W. A. Alexander, who stated that Shell had leased sizable quarters in a 23-story building now under construction in Denver.

It is contemplated that the new office will be placed in operation about the first of next year. Alexander will be in charge of the area where Shell will eventually have about 500 employees with an annual payroll and operating expense, drilling included, of about three million dollars.

Shell's current daily production in the area is about 5500 bbl produced from 100 wells.

Estimate of Texas Reserves Planned for First Time

The Texas Petroleum Research Committee early next year will publish the first detailed estimate ever made of Texas' primary and secondary petroleum reserves, Dr. George H. Fancher of the University of Texas announced.

TPRC's purpose is to find ways to increase secondary petroleum recovery and, at the same time, provide graduate training in petroleum engineering. Its major report will give results of a two-and-a-half-year study of Texas' 3150 oil fields. The agency's scientists have made extensive surveys of every oil field in the state to determine possibilities of increased secondary recovery through improved techniques.

Permian Basin Show Gets New Headquarters

The Permian Basin Oil Show will be held in a new building to be situated in "Fair Park" on 42nd Street between Andrews Highway and North Golder at Odessa, Texas.

The new Coliseum will provide one-third more space than existing facilities.

Constructed of masonry, concrete and steel, it will be 288 ft long by 208 ft wide. Office and lobby space measuring 24 by 64 ft will project from the main building.

Land was donated by the City of Odessa and the Colorado River Municipal Water District, whose reservoirs are situated in the same vicinity. The Fair Park and Coliseum will be completed well in advance of the 1954 show. Planned as the Madison Square Garden of the Southwest, its facilities include hardwood floors, electrical outlets, and 72-ft ceilings. Permanent bleachers will line the two lengthwise walls, looking into arena.

Annual Meeting Planned

The thirtieth annual meeting of the Pacific Section of the American Association of Petroleum Geologists, Society of Exploration Geophysicists, and Society of Economic Paleontologists and Mineralogists will be held jointly at the Biltmore Hotel, Los Angeles, California, Thursday and Friday, November 5 and 6, 1953.

John Adams, Standard Oil Company, Midland, Texas, national president of AAPG will discuss association affairs at the joint luncheon meeting to be held at noon on Thursday in the Renaissance Room of the Biltmore Hotel.

The SEG is meeting jointly with the Institute of Geophysics of University of California on November 4, at UCLA, and on Thursday and Friday, November 5 and 6, in the Galleria Room of the Biltmore. Dr. Daniel Silverman, Stanolind Oil and Gas, Tulsa, Oklahoma, will be the guest speaker at their joint dinner on November 5, at UCLA. Dr. David Griggs, UCLA, will be the guest speaker at the luncheon on Friday, November 6, to be held in the Renaissance Room of the Biltmore.

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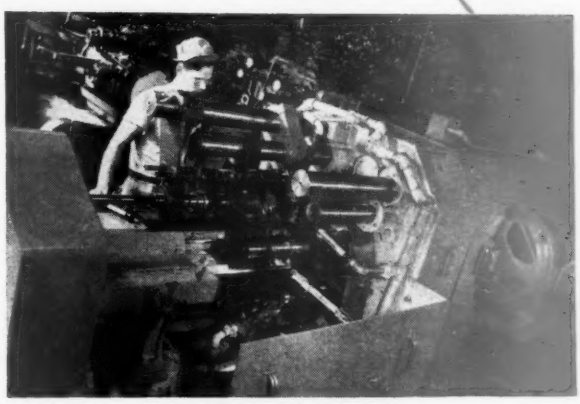

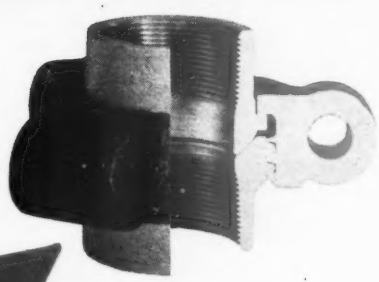

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WHAT'S DOING IN DRILLING

KANSAS

★ Cities Service Oil Company anticipates the testing of the Cherokee and Morrow sands below present producing horizon in the tri-state Hugoton gas field at the No. 1 Holt, Seward County, Kansas. Contract is for 6500 ft with operations to begin soon.

OKLAHOMA

★ Magnolia Petroleum Company completed two extension wells in the northeast Purdy field of Garvin County from the Springer zone, through perforations 8964-73 ft, with GOR 515-1. Its Victoria Unit No. 1 flowed 509 bbl of oil a day through a ½-in. choke. The No. 1 Duncan-Alliance flowed 815 bbl of oil, GOR was 615-1 through a ½-in. choke, also from the Springer.

In the East Brady pool of Garvin County Superior Oil Company's No. 2 Curtiss was completed from Hart zone through perforations 7855-74, producing 115 bbl of 42.4 degree crude per day through a 16/64-in. choke. The GOR was 712-1.

★ Signal Oil and Gas Company's No. 1 Carlisle in the same area plugged back from 5390 ft for completion after fracturing of 460 bbl per day from perforations 4467-75 and 4547-70.

★ In the South Erin Springs pool of Garvin County, the Cities Service Cunningham No. 1, a quarter mile NW extension to the Hughes B No. 1, pool discovery well, flowed at the rate of 389 bbl of oil in 24 hours through a 22/64-in. choke from the Springer sand. The Hart sand has been perforated from 8285 to 8315 ft, but no tests have been made.

★ In the Northeast Purdy pool in Garvin County the Cities Service Bridwell No. 1 extended the pool a quarter of a mile northwest when it flowed at the rate of 183 bbl in 24 hours through a 16/64-in. choke from the Springer sand, with perforations from 9700 to 9763 ft. The well is located SE NW Section 2-3n-4w.

★ In Pawnee County, Cities Service Caesar B-1, about 15 miles northeast of Cushing gave a West extension to the South Meramec pool when it flowed 105 bbl of oil in 24 hours through a 3/16-in. choke from perforations in the Red Fork sand from 2953 to 2978 ft.

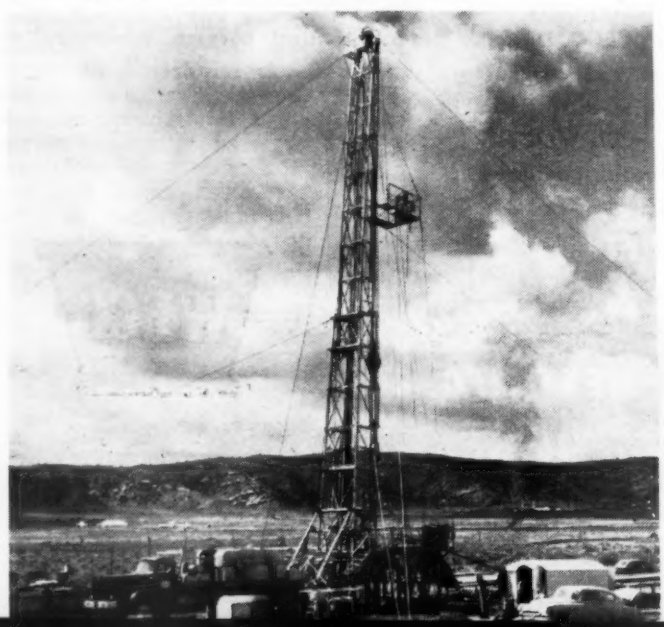
CANADA

★ Pacific Petroleums, Ltd., have completed a fifteenth producer from the Erskine field in Alberta. Their No. 3 well is being completed after recovering 1920 ft of oil from the interval 5393-5403 ft, according to Pacific Petroleum, Ltd.

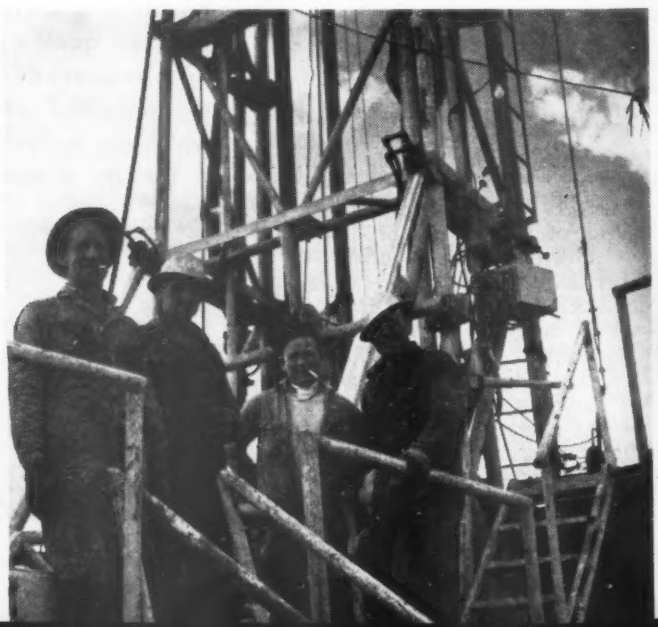
★ Sinclair Oil Company has completed a Viking formation gas discovery, which flowed at a rate of 6,000,000 cu ft through a ¼-in. choke with distillate unreported.

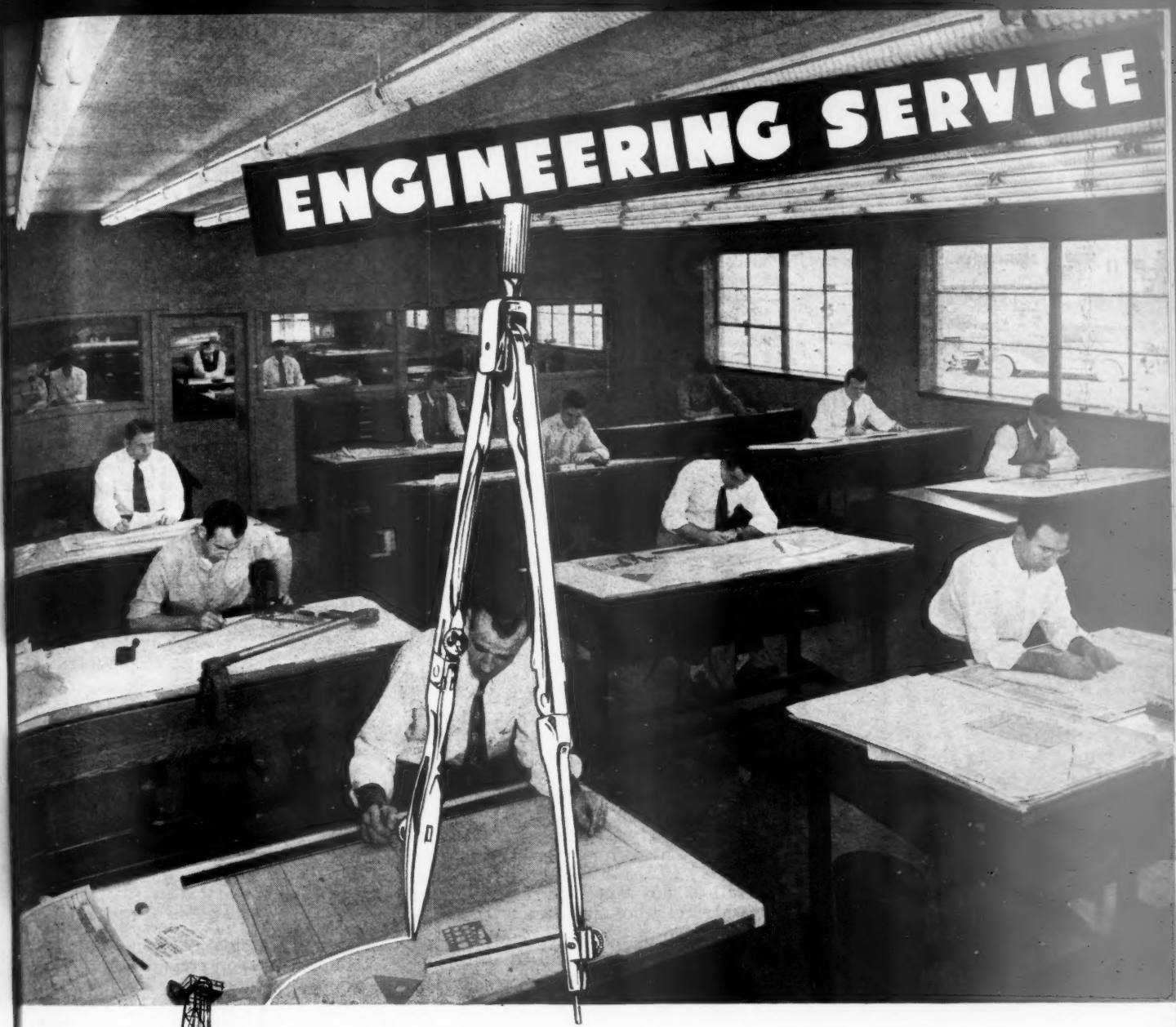
OPERATING personnel observe action of Martin-Decker drilling control at Ohio's deep test in Kern County, California.

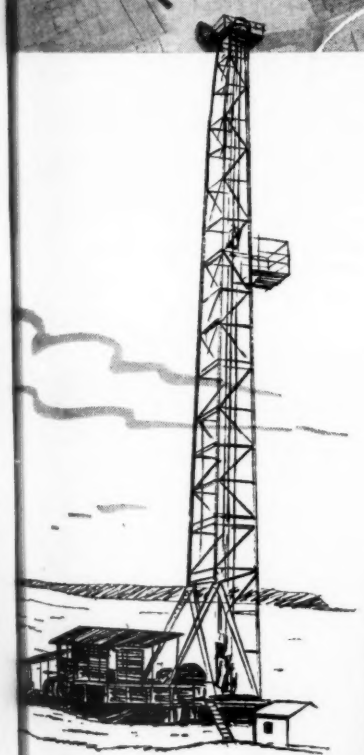
B. F. ALLISON Drilling Company, Casper, Wyoming, Rig No. 5 operates for Husky Oil Company on their KC No. 15, in Grass Creek field of Wyoming.



DAYLIGHT crew on Allison Rig 5 pauses for a few minutes. Left to right are: George Shaner, driller; Sherman Pitt; G. A. Scholz, and Gus Pitt.







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DRILLING

ARKANSAS

★ Pettit production in the Springhill field of Columbia County has been extended through the completion of Mid-Continent's No. 1 Ensey. The pumping I.P. was reported as 216 bbl per day from perforations from 6004-6063. This extension well lies north of the field.

CALIFORNIA

★ The Union Oil Company has discovered deeper production in their No. 62-34 Kern County well in the Rio Bravo field. Deepened to 13,499 ft, the well was plugged back for a completion of 11,606-698 in the Hebling sand. I.P. flowing was 330 bbl of 34.5 degree oil through a 18/64-in. choke.

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★ In the Cymric Pool Superior Oil Company's No. 1 Cymric Unit establishes new pay from 6494-6530. I.P. after plugging back at 12,022 ft for completion was 137 bbl of 27 degree oil daily, flowing through a 14/64-in. choke.

WEST TEXAS

★ The Elkhorn (Ellenburger) field has been extended ½ mile north with completion of Superior Oil Company's 1-27 University. The well has a daily flowing potential of 240 bbl of 40.5 gravity oil plus 0.4 per cent basic sediment. Flow was through a 16/64-in. choke from a perforated zone at 7303-59 ft.

★ The Andrews (Wolfcamp) field of Andrews County was extended ¼ mile east with completion of The Texas Company's Aurelia Cobb No. 1, located one mile west of Andrews. The well has a calculated daily flowing potential of 348.2 bbl of 37.9 gravity oil plus 0.3 per cent basic sediment. GOR was 694.1. Production was through a 32/64-in. choke and perforations were between 8617-28 ft and between 8641-55 ft. The section was acidized with 500 gal. Flowing potential was based on an actual 14½-hour flow of 270.79 bbl.

★ The Texas Company also extended the Clarence Sharbauer (Strawn) field of Midland County ¼ mile east with completion of its 3-B-NCT-1 Sharbauer. Potential is 314.64 bbl daily of 56.1 gravity oil with a GOR of 2200-1. Production was through a 19/64-in. choke and perforations were between 10,311-10,343 ft. Tubing pressure was 750 pounds. The section was washed with 500 gal of mud acid.

★ Phillips Petroleum extended the Andrews Northeast well in Andrews County with completion of its No. 3-cc University. It was completed with flowing potential of 2000 bbl 44.3 gravity oil.

★ Skelly extended the Hulldale field of northern Schleicher County one location east with completion of its No. 7 W. A. Davis for a calculated daily flow of 1059.18 bbl of 36.9 gravity oil, no water, with GOR of 859.1.

The potential was based on an actual four-hour flow through a ¾-in. choke and perforations between 5654-72 ft. Tubing pressure was 110 lb.

NORTH DAKOTA

★ The completion of the Rudman No. 3-J-H Hanson in Montrail County, North Dakota extends the Tioga field one mile to the northeast. Reported I.P. was a 500 bbl a day rate on a 12/64-in. choke.

LOUISIANA

★ Carter Oil Company's No. B-1 Crystal extended the Ivan field of Bossier Parish ¾ of a mile northwest through completion of No. B-1 Crystal. I. P. on this well was 430 bbl of 48.3 degree oil through a 12/64-in. choke, with tubing pressure just under 3500 lb psi. Producing section has been designated as the "Crystal Conglomerate" zone. Yield is through perforations 9674-9742.

★ Magnolia Petroleum Company has opened a new pay zone on its State Lease 766, Block 72 of the ship shoal area off Terrebonne Parish, with the No. B-4 well flowing 568 bbl of oil daily, with GOR of 755-to-1, through a 12/64-in. choke, from sand zone at 9786-94 ft. The well had been drilled to 12,261 ft. A directionally-drilled hole is starting from the same platform.

WYOMING

★ W. F. Hammond announces the completion of the No. 1 Gaskill in the Cheyenne River area of Western County, as a possible extension of the Clareton field. I.P. was 1500 bbl per day through a ½-in. choke. New Castle sand perforations were from 7036-7051 ft.

MEXICO

★ Mexico will hit a new high in the number of wells drilled this year, according to a report prepared by Pemex, Mexican oil monopoly, for President Adolfo Ruiz Cortines. The company reported that 368 wells are on the program, more than the total of all wells drilled between 1937 and 1948. This total is near the 400 wells per year, which oil men have estimated are necessary to fulfill that country's needs.

Although the number of wells drilled this year is higher than any year since the industry was expropriated by the government, it is not as high as the number drilled from 1923 to 1927.

Rotary Rigs Operating in Oil Fields of United States and Canada*

	Aug. 10	Aug. 17	Aug. 24	Aug. 31	Sept. 7	Sept. 14
Pacific Coast	170	159	167	173	176	173
Oklahoma	366	369	363	367	357	351
Kansas	159	156	158	155	165	154
Rocky Mountain	273	271	258	258	273	275
Canada	180	178	173	173	187	177
Ark-La-Tex	150	146	146	183	185	179
West Texas and New Mexico	467	466	481	489	493	475
Gulf Coast	570	576	581	531	513	501
Illinois	152	153	143	148	144	148
North Texas	329	324	301	306	326	315
Total	2816	2798	2771	2783	2819	2748

*As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company.

FIRST NAME in Drilling Rigs!

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Pictured is Elmer Whipple, Vice-President, San Joaquin Drilling Company, watching the remote control operation of their new Wilson Super Titan "66" Rig.

"Money making rigs" — that's how WILSON RIGS have been known — even back when they were first introduced and were destined to revolutionize drilling 30 years ago! That advanced all around better performance — that high standard of quality from the smallest bearing to the largest shaft — that extra ruggedness that assures years and years of service after the rig has paid for itself — is engineered into every WILSON RIG. The ONLY RIG with ALL FRICTION CLUTCH DRIVE! And now — the new WILSON RIGS embody the greatest features in our 30 years of manufacturing experience. Let us give you more facts — money making facts!

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XUM

EXPLORATION ACTIVITIES

MISSISSIPPI

★ Two developments of note have occurred in Mississippi. The depth extension of the Soso field by Gulf Refining Company with completion of its No. 1 J. W. Bailey as a Lower Cretaceous discovery is most significant. Previous production in the field has been from the Eutaw sand of Upper Cretaceous age. The Bailey No. 1 was completed through casing perforations between 11,966 and 11,990 ft. Early completion reports indicated an IP in excess of 200 bbl of high gravity oil. Final report was 195 bbl of 43.7 deg oil on 7/64-in. choke. Producing zone has been identified as Glen Rose.

★ The other operation of significance is the completion of the Magnolia No. 1-A Snow in Monroe County in Northeastern Mississippi. Finaled through perforations from 4753 to 4756, the well flowed with a tubing pressure of 250 lb and had an early IP of 216 bbl of 35 deg oil through a 12/64-in. choke in 24 hours. The producing zone is identified as the Knox dolomite. The later appearance of slight water cut with a subsequent reduction of the tubing pressure to 140 lb and productivity to 44 bbl per day on a 10/64-in. choke may lessen the value of the well but does not diminish the importance of the establishment of production in this zone.

PERU

★ Peruvian Pacific Petroleum Company, a wholly owned subsidiary of Cities Service Company, has acquired approximately 300,000 acres of exploration and exploitation lands in the Talara producing area on the coast of Northern Peru. The acquisition is under a contract with the Empresa Petrolera Fiscal.

The company has also entered filings on twenty exploration concessions totalling 2,405,000 acres in the Montana region of Eastern Peru. In this same area the Texas Petroleum Company (Peru), the Socony-Vacuum Oil Development Company (Peru), and Richmond Oil Corporation (Standard of California) have recently made applications for similar tracts. The new Cities Service subsidary is entering into a working agreement with the Richfield Oil Corporation whereby each company will participate in the exploration and exploitation on a fifty-fifty basis. In the initial stage the principal operations will be geological work and exploratory drilling.

CALIFORNIA

★ Discovery of a new shallow producing zone on the flanks of the old Buena Vista Hills field of the San Joaquin Valley in the Naval Petroleum Reserve No. 2 has been announced. Standard Oil Company of California has completed its No. 73-17D flowing 572 bbl of 20.5 deg crude from the Echegoin sand at about 3550 ft. Test was made on an 18/64-in. choke with a flowing tubing pressure of 380 lb and with 120 lb casing pressure.

★ In Yolo County, Signal Oil Company has staked a 5500-ft test about 7½ miles north of the Dunnigan Hills gas field. This test is to be drilled jointly with Monterey Oil Company. Union Oil meanwhile has prepared to drill its No. 1 Waughaman in the Pescadero area of Santa Clara County while The Texas Company will start a slant hole test of the area under the Long Beach Airport. Latter is reported to have paid over $100,000 in addition to a royalty of 42.6 per cent.

ALASKA

★ Discovery of active oil seepages in the little-known Malaspina Glacier area of southern Alaska has been announced by Secretary of the Interior.

The secretary said Darwin L. Rossman and George Plafker, geologists, have found several active seepages of high-gravity oil on two streams that drain into a large unnamed ice-dammed lake on the south flank of the Samovar Hills.

The hills are located about 30 miles from the Gulf of Alaska coast, midway between Icy and Yakutat Bay.

The Icy Bay-Yakutat Bay foothills belt of the St. Elias Mountains is being surveyed to determine petroleum possibilities in the Gulf of Alaska area.

Seepages of high-gravity oil have long been known in the northwestern area of a 300-mile belt that borders the Gulf of Alaska. It is in that area that the Phillips Petroleum and Kerr McGee Company jointly are carrying out exploration for oil.

The Samovar Hills lie in the north central part of the belt and the newly discovered oil seepages are 45 miles northeast of the nearest previously known.

OKLAHOMA

★ The Texas Company announced the opening of a new pool in the Hunton lime upon completion of its W. S. Damron No. 1, Seminole County, Oklahoma, as a producer. Through perforations from 2702 ft to 2712 ft, the well flowed 205 bbl of 30 gravity oil and no water through a ⅛-in. choke on a 24-hour production test. Tubing pressure was 235 lb. Named the Northwest Welty pool, the new field is approximately one mile from the nearest production, which is southeast.

★ Pure Oil Company is completing its No. 1 Hobaugh, east of Noble in south-central Cleveland County. The well flowed 215 bbl of oil in 16 hours through a 10/64-in. choke and 102 bbl in 8 hours through a 11/64-in. choke. Flow was through perforations 7893-7959 in the Tulip Creek sand.

TEXAS

★ Woodley Petroleum Company opened a new producing zone in Houston County with completion of Bruton No. 2, for a 24 hour IP of 214 bbl of 37.5 deg oil on a 9/64-in. choke. Flow was through casing perforations 8690-8712 ft in the Woodbine section. Flowing tubing pressure was reported in excess of 1000 lb, with GOR of 623-1.

★ In Andrews County Continental reports an IP of 1170 bbl of 44.5 deg oil through a ¾-in. choke from the Devonian. Production is through perforations in zones from 12,432-12,575 ft. GOR of less than 100-1 with a flowing tubing pressure of 100 lb has been reported.

★ In Live Oak County the Houston Oil Company at its No. 1 Skaggs has a wet gasser. From the massive sand zone topped at 6948 well gaged 29.7 bbl of distillate per million ft of gas while flowing at a rate in excess of 3,400,000 cu ft per day.

★ South of Midland Fred Turner, Jr., No. 1 Parker on drill stem test flowed an estimated 40-50 bbl hourly from the Wolfcamp. Test interval was 8554-8613 ft. Oil surfaced in 72 minutes and was permitted to flow into pits for 13 minutes. Well is now drilling ahead.

★ In Smith County Humble Oil and Refining's No. 1 Hubbard Timms has been completed as a flowing oil well from the Pettit lime. Reported IP on a ¼-in. choke from perforations 8015-32 was 197 bbl of 41 degree oil.

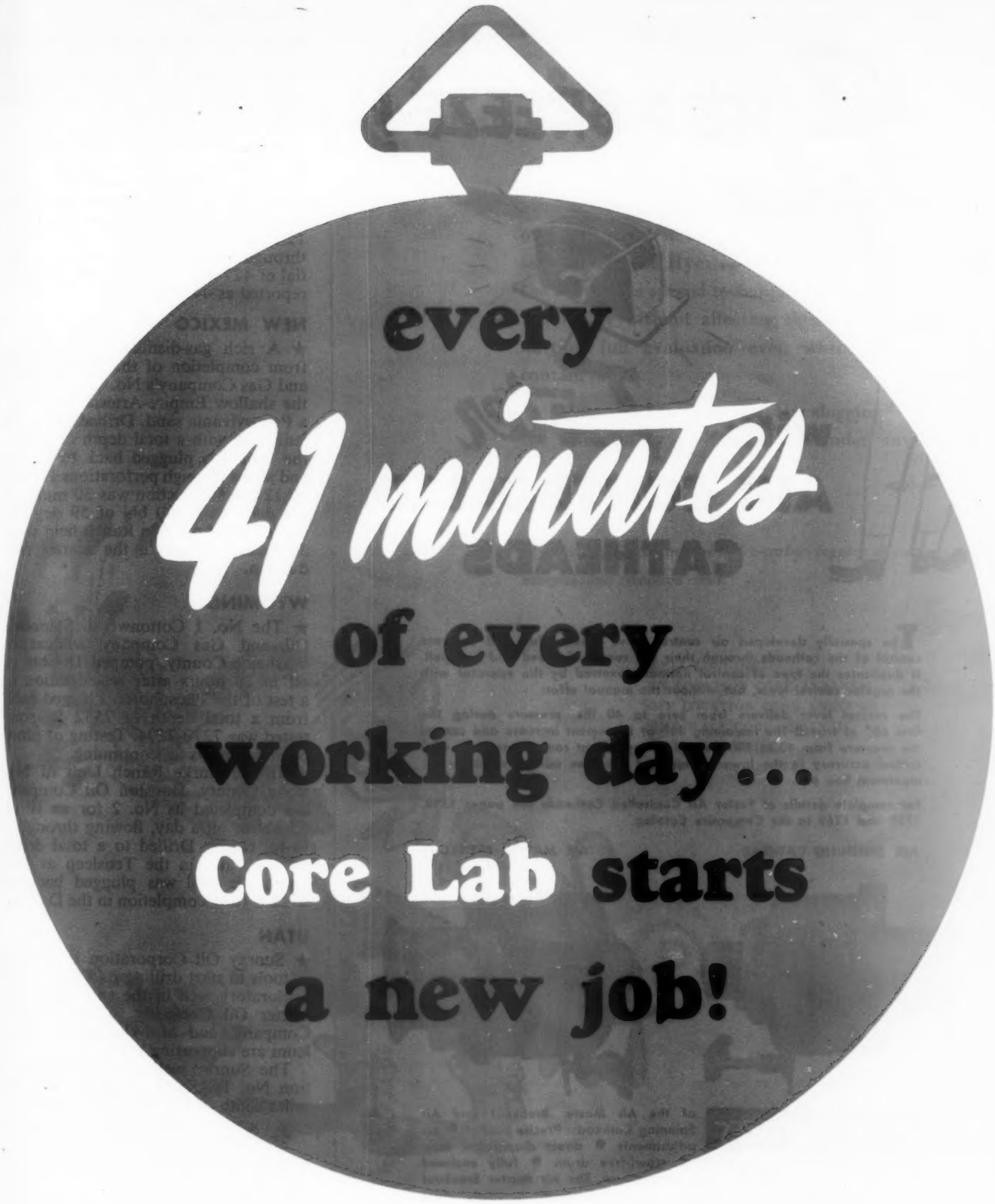
GEORGIA

★ Governor Herman Talmadge announced large-scale oil explorations will start in the Georgia coastal area under backing of some of the nation's largest oil interests. Col. E. B. LaRue, Athens, Texas, oil man, will direct overall plans for the exploration activities. A $100,000 reward has been posted to the discoverer of the first commercial oil well in the area. The first test well will be drilled on Colonel's Island in Glynn County, on privately-owned land.

ILLINOIS

★ Prospects for opening a new Rosiclare lime pool in Wabash County appear to be good. Coy Oil Company, in its No. 3 Mary Kerwin, swabbed at the rate of 12 bbl of oil an hour after drilling plug from the interval 2895 to 2901 ft. The Rosiclare lime has not been previously productive in the immediate vicinity though there has been production from shallower pays.

★ Elsewhere in Illinois, there were two new oil fields and one gas field indicated through completions in August. Both of the oil discoveries were in Richland County and have been designated as Amity West and Amity South. The new gas discovery was in Edgar County and was named Dudley West.



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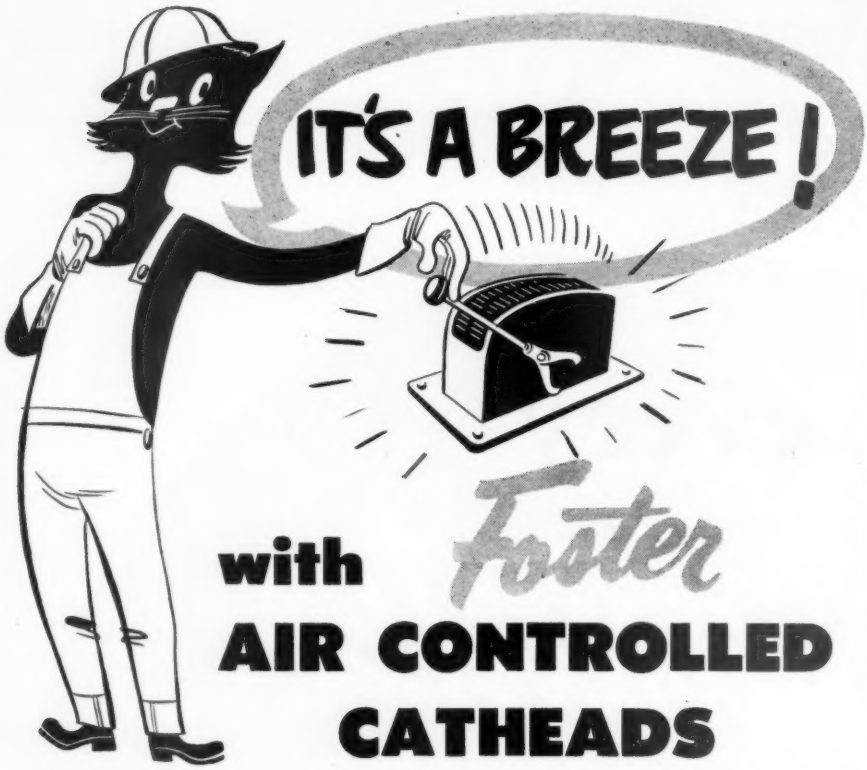

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For complete details of Foster Air Controlled Catheads see pages 1758, 1759 and 1769 in the Composite Catalog.

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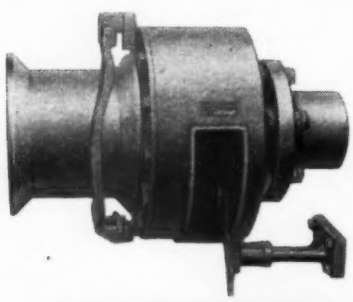
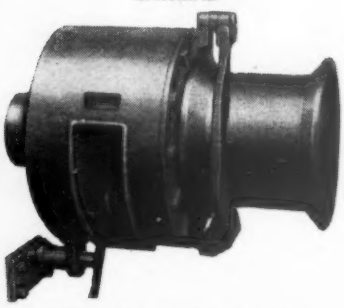


AIR MASTER BREAKOUT CATHEAD



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Rotary Sales & Service, Ltd., Edmonton, Alberta, Canada
Woodco Sales & Service, Great Bend, Kansas
W. O. Nelson, Farmington, N. M.

LOUISIANA

★ Stanolind has discovered a new pay zone in the old Edgerly field of Calcasieu Parish. Tested through 8/64-in. choke and flowing from perforations 3703 to 3712, IP was 100 bbl per day of 29 deg oil. Gas oil ratio was 248 to 1 with production from a Miocene sand.

★ Drilled to a depth of 12,881 ft in Beauregard Parish, Sunray Oil Corporation No. 2 Long Bell has been completed through perforations 12,668 to 12,696. Potential test was made through a tubing choke with a potential of 427 bbl a day. Gas oil ratio was reported as 4450 to 1.

NEW MEXICO

★ A rich gas-distillate well resulted from completion of the Stanolind Oil and Gas Company's No. 1 State AB in the shallow Empire-Artesia area from a Pennsylvania sand. Drilled to the Ellenberger with a total depth of 12,431 the well was plugged back to 10,270 and tested through perforations 10,102-10,127 ft. Production was 30 mmcf of gas daily with 780 bbl of 59 deg distillate. The Anderson Ranch field some 30 miles northeast is the nearest production.

WYOMING

★ The No. 1 Cottonwood, Stanolind Oil and Gas Company wildcat in Washakie County, pumped 184 bbl of oil in 20 hours after reacidization in a test of the Phosphoria. Plugged back from a total depth of 7552 ft, zone tested was 7270-7294. Testing of other possible shows is continuing.

★ In the Burke Ranch Unit of Natrona County, Houston Oil Company has completed its No. 2 for an IP of 65 bbl of oil a day, flowing through a ¼-in. choke. Drilled to a total depth of 8367 and in the Tensleep at that point, the well was plugged back to 6722 ft for a completion in the Dakota.

UTAH

★ Sunray Oil Corporation is moving in tools to start drilling its first wildcat exploratory well in the state of Utah. Carter Oil Company, Glenwood Oil Company, and Mid-Continent Petroleum are supporting the test.

The Sunray well is Utah Corporation No. 1, Uintah County, some 70 miles south of the town of Vernal and near the small Indian village of Ouray.

The wildcat is located on a 20,000-acre block which the company holds in the Uintah Basin of northeastern Utah, and is projected to a depth of approximately 6000 ft to test possible oil sands in the Green River, Wasatch and Mesaverde. Loffland Brothers are the drilling contractors.

Uintah Basin is the major area under exploration in Utah at the present time and accounted for the major portion of the state's geophysical activity in 1951-52. The Rangely, Ashley Valley, Roosevelt, Red Wash, Duchesne, South Myton, and Peters Point fields lie within the vast area much of which is still unexplored for oil.

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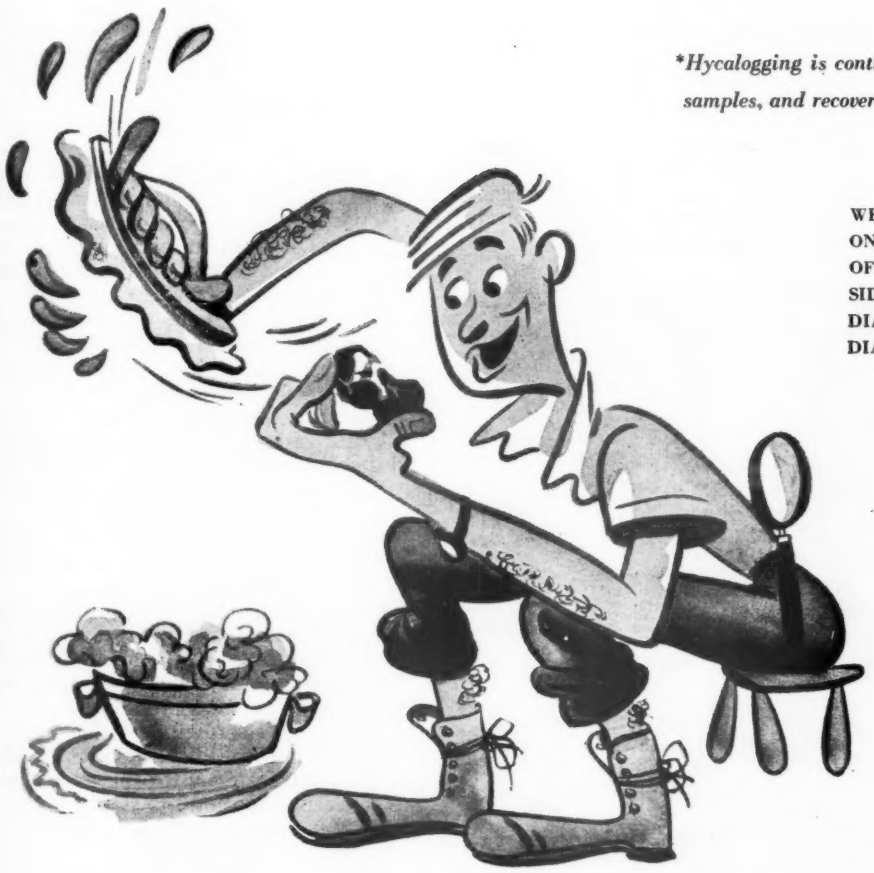

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RUNNING TOUR WITH MEN IN THE INDUSTRY

▸ **H. W. Manley** has resigned as vice president in charge of production, refining, and natural gasoline departments of Sunray Oil Corporation. He has announced plans to become an independent oil operator. Manley joined Sunray in 1950, and prior to that was a vice president and production superintendent of the former Barnsdall Oil Company when that company was merged with Sunray.

▸ **M. W. (Mel) Sheppard, Jr.,** recently celebrated his 20th year of service with Shell Oil Company. On the occasion he was presented the traditional emerald-studded Shell service emblem by S. F. Bowlby, vice president. Well known as Shell's land manager for the Pacific Coast area, Sheppard began his career with the company as a roustabout in the Ventura Avenue field following his graduation from Princeton University as an electrical engineer.

▸ **Edward A. Koester,** consulting geologist, Wichita, Kansas, and **Karl A. Mygdal,** Pure Oil Company geologist, Chicago, Illinois, candidates for president, head the list of candidates for 1954-55 offices of The American Association of Petroleum Geologists, as revealed in the report of the nominating committee released by **John Emery Adams,** president of the Association. Other nominees are: for vice president, **Graham B. Moody,** Standard Oil of California and **Walter H. Spears,** Union Producing; for secretary-treasurer, **William A. Gorman,** Rycade Oil and **Elliott H. Powers,** present secretary-treasurer, Southern Production; for editor, **Armand J. Eardley,** incumbent, University of Utah, Salt Lake City, and **W. T. Thom, Jr.,** Princeton University, Princeton, New Jersey.

Additional nominations may be made by written petition bearing the signatures of 50 or more Association members received at AAPG headquarters in Tulsa, Oklahoma, not later than November 15, 1953. Early in February, 1954, the thousands of ballots will be counted and winners in this worldwide ballot will take office at the close of the 39th annual meeting of the Association to be held in Kiel Auditorium, St. Louis, Missouri, on April 15, 1954.

▸ **Leon A. Davis,** petroleum engineer in Magnolia Petroleum Company's Shreveport, Louisiana, producing district, has been made assistant production foreman in that district.

J. W. Nicholas

C. Sheppard, Jr.

G. L. Noble, Jr.

▸ **James W. Nicholas** has joined Housch Drilling Company and other Housh enterprises in the capacity of production engineer. Nicholas is a graduate of the University of Texas. Following his graduation, he was employed by the Railroad Commission of Texas for a short time and then went with Stanolind Oil and Gas where he was employed in various engineering capacities for 10½ years. During the last five years he has been in Houston serving as drilling and development engineer for Stanolind.

▸ **Charles Sheppard, Jr.,** has been named area manager of the Gulf Coast with headquarters in New Orleans, Louisiana, by Cherokee Laboratories, Inc., of Tulsa.

Previous to his coming with Cherokee, Sheppard was associated with the Buras office of the Gulf Oil Company as petroleum engineer in charge of drilling muds. His association with the oil industry dates back to 1949 when he joined Gulf as a roughneck in a drilling crew.

▸ **George L. Noble, Jr.,** has been named president of Stanwell Oil and Gas Limited, Canadian independent oil company, it was announced by the board of directors. Stanwell has interests in 10 producing oil wells in Alberta, as well as in other oil properties in Canada and the southern United States. In June, 1953, a controlling stock interest in Stanwell was acquired by Blair Holdings Corporation.

Noble has had extensive experience in all phases of the oil business and has also held important posts in government. Since May, 1951, he has headed the Small Business Office of United States Army Ordnance.

▸ **J. R. Nichols,** gas plant superintendent, Seeligson compressor plant, for Humble Oil and Refining Company was transferred to the Opelousas gas plant, replacing **H. D. McClain,** who moved to the Katy Gas cycling plant as assistant cycling plant superintendent.

J. W. Smith, district petroleum engineer, Livingston district, Gulf Coast division, was transferred to the Colorado district, Southwest Texas division, as district petroleum engineer.

J. A. Reed, returned from military leave to the Galveston Bay district, Gulf Coast division, as petroleum engineer. He went on military leave from the Winters district, North Texas division, where he was petroleum engineer.

Eugene G. Copley, roustabout gangpusher, Katy Gas cycling plant, was named compressor plant foreman at the Seeligson compressor plant, Stratton district.

George N. Hart, gas plant pumper and gager at the Katy Products terminal, Galena Park, was promoted to roustabout gangpusher at the Katy gas cycling plant.

John F. Kasper, Jr., returned from military leave as senior division clerk in the Southwest Texas division office. He was assistant district clerk at the Government Wells district when he went on military leave.

Horace C. O'Rear, toolpusher, was transferred from the Kelsey district to the Scott and Hopper district, Southwest Texas division.

L. W. Cheaney, assistant district chief clerk, Avery Island district, Louisiana division, resigned August 10.

H. M. Lemex, supervising petroleum engineer, drilling equipment division, Houston office, was transferred to the Gulf Coast division office as supervising petroleum engineer.

T. V. Miller, supervising petroleum engineer, petroleum engineering division, Houston office, was transferred to the Gulf Coast division office as supervising petroleum engineer.

R. A. Watson, supervising petroleum engineer, Gulf Coast division office, was transferred to the petroleum engineering division office as supervising petroleum engineer.

▸ **Robert L. Hoss** was recently appointed division engineer of Midwest Oil Corporation with offices in Denver, Colorado. He was formerly senior petroleum engineer with Humble Oil and Refining Company.

▸ **Bert W. McLean** has been appointed to the newly created position of assistant traffic manager, Gulf Coast production division, Beaumont, Texas. McLean will be in charge of traffic operations for the Gulf Coast production division. Since 1944, he has worked in the Beaumont office transportation department. He joined Sun in 1935.

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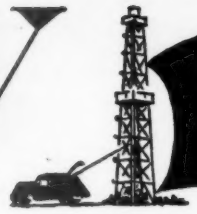

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RUNNING TOUR

▸ **E. C. Doell** and **Antonie Paap,** Standard Oil Company of California have both been assigned to the staff of the chief geologist in San Francisco; **H. C. Bemis,** exploration superintendent for the Southern district, Los Angeles; and **E. G. Dobrick, Jr.,** chief geophysicist, Oildale.

Doell, who joined Standard in 1933, was previously Southern district exploration superintendent. Paap, a native of the Netherlands, was educated abroad and joined an overseas subsidiary of Standard's in 1936. Bemis, a University of California graduate, joined Standard in 1937. Dobrick was formerly with The California Company, Standard subsidiary, as division superintendent of its Eastern exploration division.

▸ **Virgil E. Spradlin** has announced his resignation from Skelly Oil Company in Wichita, Kansas, and has been named district geologist—Kansas district—with Mayfair Minerals, Inc. Spradlin is a graduate of the University of Oklahoma and prior to joining Skelly was Kansas district geologist with Pure Oil. Mayfair's Kansas headquarters will be in the Rule Building, Wichita.

▸ **John H. Gatchell** has joined the staff of the production and exploration division of Lion Oil Company as a geologist. He will be attached to the central region, which has headquarters at Wichita, Kansas. Gatchell, a native of Sanford, North Carolina, has been an instructor in geology at Christian College, Southwest Louisiana Institute, and the University of Missouri. Prior to his employment by Lion Oil he was assistant district geologist for Atlantic Refining Company.

▸ **Harold D. Hansen** has recently been appointed petroleum engineer for the Colorado-Nebraska field of The British-American Oil Producing Company's Northwestern district. Hansen joined British-American after nearly seven years in Peru and Colombia with the International Petroleum Company, Ltd.

He holds a BS degree in chemical engineering.

▸ **L. L. McDonald** has been promoted to assistant division manager of the Texas producing division of The Pure Oil Company in Fort Worth, Texas. He was formerly in Chicago, Illinois.

▸ **Paul Weaver** has joined the staff of the Texas A. and M. College System as a distinguished research geologist, it was announced by Chancellor M. T. Harrington. Weaver, who recently retired as technical assistant to the vice president of Gulf Oil, Houston, will devote part time to teaching seniors and graduate students of A. and M. College in ground water geology and will serve as a consultant for A&M's water research and information center.

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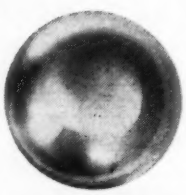

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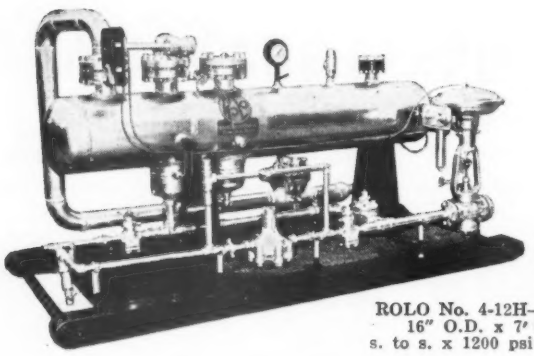

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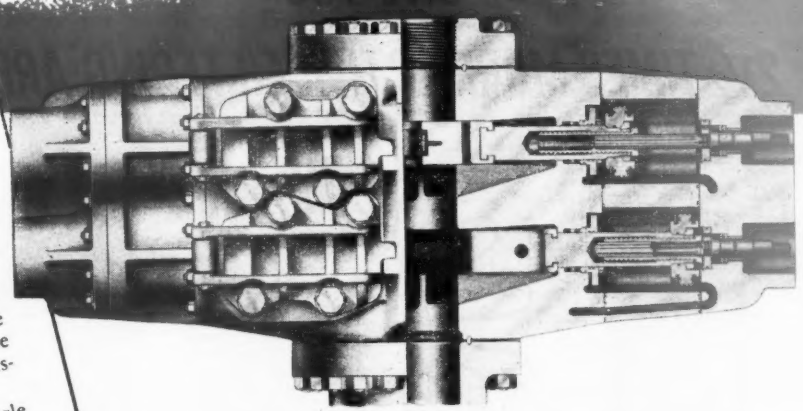

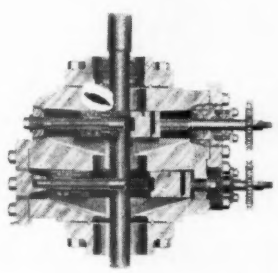

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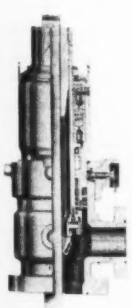

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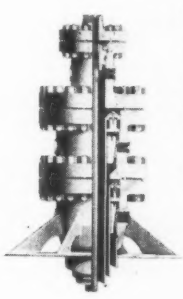

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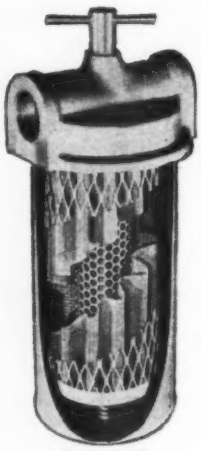
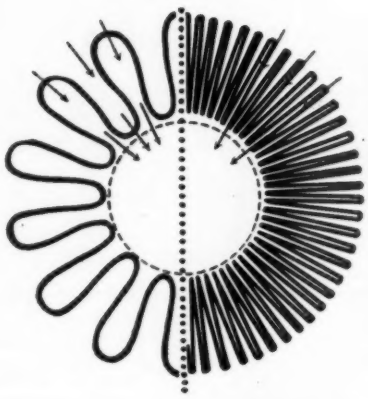


LINE TYPE (cutaway)



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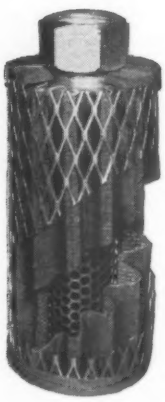

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Available in sump and line models, in capacities from 5 to 100 G.P.M. and in monel mesh sizes from 30 to 200. All models operate in any position. Line models may be serviced without disturbing pipe connections. For efficient filtration of liquids in all HYDRAULIC and LOW PRESSURE SYSTEMS, Marvel is your answer.

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RUNNING TOUR

Arthur B. Van Tine has joined the staff of the department of geology at Rensselaer Polytechnic Institute, it is announced by Dr. Paul E. Hemke, dean of the faculty. He will be an associate professor in the department headed by Dr. Joseph L. Rosenholtz and will teach courses in petroleum geology.

Van Tine taught general geology at Colorado School of Mines, and served as a consultant in oil reservoir geology for Shell, Pure and a number of independent firms.

C. R. Dodson resigned recently as professor and head of the petroleum engineering department at the University of Southern California. He plans to spend full time on consulting work in the office of Stanley, Stolz and Dodson, Los Angeles firm of consulting petroleum engineers and geologists. He has been a partner in the firm since July, 1951.

Dodson was with the Standard Oil Company of California from 1936 to 1947. He resigned in 1947 to take charge of the petroleum engineering department at University of Southern California and engage in private consultation. He has been active in American Institute of Mining and Metallurgical Engineers and American Petroleum Institute work and is a charter member of the Petroleum Club of Los Angeles.

Dr. Frank G. Miller has been appointed to head the department of petroleum engineering at Stanford University, commencing with the autumn quarter of 1953, to succeed **Dr. Richard V. Hughes** who recently resigned to accept a position in industry. Dr. Miller comes to Stanford from the U. S. Bureau of Mines where he has been engaged as assistant supervising engineer, petroleum and natural-gas branch, Region III, San Francisco, California. He has specialized for many years in studies of fluid behavior in porous media, and in the fundamentals of oil-reservoir engineering. Evening courses in these subjects have been conducted by him for six years at the University of California and for one year at Stanford. He has written a number of technical papers including a Bureau of Mines bulletin, now in press, relating to multiphase flow theory and well spacing. His BS degree was awarded in 1933 by the University of California, in petroleum engineering, and his MS and PhD degrees were awarded in 1939 and 1950, respectively, by the same institution, in mechanical engineering, with research relating to petroleum production.

Miller spent his first three years after college graduation in 1933 with the Union Oil Company of California.

H. G. Van Horn has resigned from the Shell Oil Company in Corpus Christi, Texas, to accept a position as petroleum engineer with the Colorado Interstate Gas Company in Colorado Springs, Colorado.

Synthesis of Petrochemicals—3

Ethylbenzene—Mother of Petrochemicals

A direct intermediate for styrene, or ethylbenzene, this product is made in huge quantities by two processes, the high-pressure, silica-alumina catalyst and the low pressure, aluminum chloride catalyst methods

ARCH L. FOSTER*

ETHYLBENZENE was relatively unimportant until the advent of styrene with its tremendous war-born growth as a component of synthetic rubber. This development was coupled with that of polystyrene, basic plastic material of such wide application industrially and commercially.

Ethylbenzene is the direct alkylation product of the combination of ethylene, $H_2C{=}CH_2$, with benzene, C_6H_6. Formerly obtained almost wholly from coal tar distillation, the greater portion of our benzene production now is derived from petroleum as a direct byproduct of various processes, largely catalytic cracking and catalytic reforming. Specifically, it may be made by the cyclization-dehydrogenation of hexanes by means of well-known dehydrogenation catalysts such as various metallic oxides, nickel, molybdenum, etc. Styrene goes not only into polystyrene but along with other components into different types of plastics. Styrene crawled along at the production rate of 5,000,000 to 6,000,000 lb per month until 1943 when rubber synthesis demand became strident and it jumped to more than 40,000,000 lb per month by 1945, later dropping off, again resuming its upward climb until in 1951 the production was about 65,000,000 lb per month.

*Editor, Refining and Petrochemical.

Ethylene a Product or a Byproduct

Normal sources of ethylene are two. It is formed by byproduct in the thermal as well as catalytic cracking and reforming of heavier stocks, and may be fractionated out of the overhead vapors from the fractionators on these process units. Fractionation requires in some cases refrigeration to effect condensation of ethane and heavier hydrocarbons to concentrate the desired ethylene, boiling at minus 155 F. Refrigeration may be obtained by an ammonia expansion unit or by similar operations expanding ethane, propane, etc., after liquefaction and cooling, to attain the needed low temperature in the condensers. Ethylene is highly reactive, following a large number of reaction routines for a plethora of products, polymers, and copolymers. In fact, ethylene has been considered the most important petrochemical intermediate in existence.

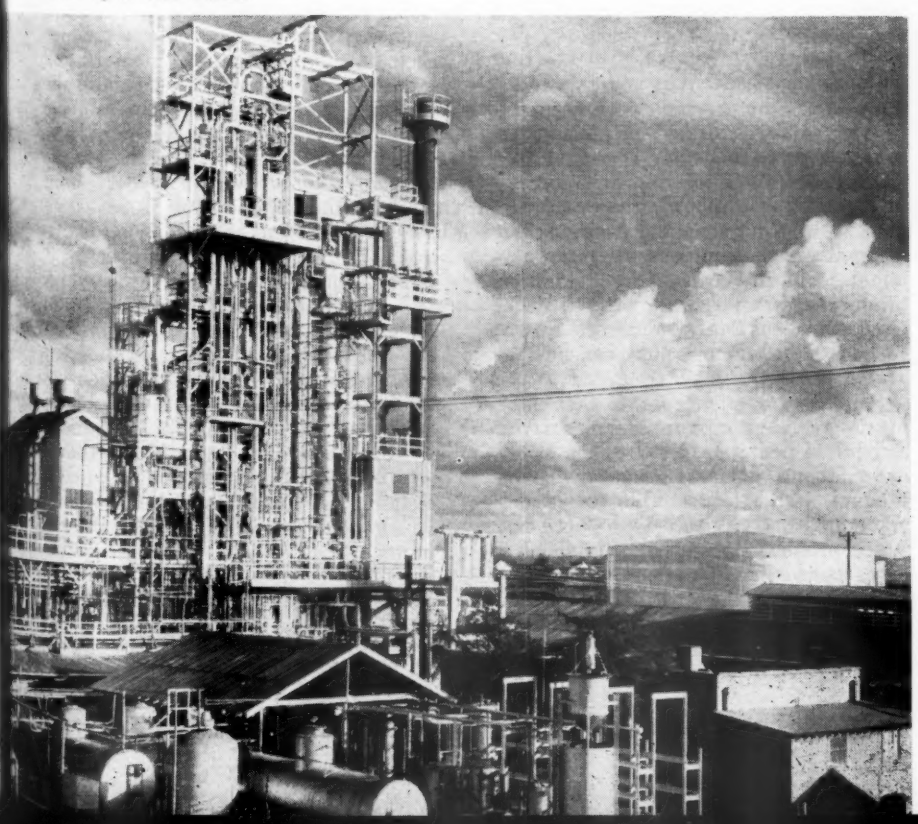
As to major details of the high-pressure process, ethylene is pumped into a stream of liquid benzene immediately after the benzene exits from its high-pressure circulating pump, a multistage centrifugal as employed by Koppers, the benzene being always in large excess in the mixture. This excess is employed to discourage polymerization of the ethylene by keeping it in small percentage dispersed in the benzene. The benzene is circulated as rapidily as is practicable and the benzene ethylene ratio is maintained as high as possible to minimize the production of byproduct polyethylbenzenes, which consumes intermediates and lowers the yield of ethylbenzene.

The benzene-ethylene mixture passes through several heat exchangers to preheat it, exchanging with benzene vapors from the overhead of the benezene recovery column—unreacted benzene from the reactor effluent, en route to recycle—and then with the reactor effluent itself just after the latter emerges from the reactor. This partially preheated benzene-ethylene stream then is brought to temperature in a, for example, gas-fired tube furnace. From this furnace the mixture enters the catalyst cases at around 900 psig and 590-600 F.

The catalyst employed in this process is a silica gel carrier on which is deposited a very thin film of alumina, Al_2O_3, a catalyst with the same basic ingredients as some catalysts for cracking heavy oils. The benzene-ethylene mixture passes through normally three fixed beds of catalyst, the temperature rising as the passage continues as the reaction of the two components is exothermic. The extent of temperature rise is determined by the throughput. Effluent reaction products pass in heat exchange with incoming mixture as mentioned above, and thence into the benzene column. During this interim the pressure is dropped from 850 psig or thereabouts to 45-50 psig, and the re-

EXCLUSIVE

The Synthesis Plant.



sulting drop in boiling point serves to distill off part of the benzene from the ethylbenzene and heavier products of the reaction. This overhead benzene imparts heat to incoming reaction mixture, is condensed and sent to the recycle-charge tank on which the benezene pump takes suction. The benzene-removing column reboiler is heated by 450 psig (460 F) steam.

Bottoms from the first or benzene column transfer by pressure differential to the second or ethylbenzene column where temperature and amount of reflux are so controlled as to minimize both the loss of polyethylbenzene overhead with the monoethylbenzene, and similarly to reduce the amount of ethylbenzene lost in the polyethylbenzene in this tower bottoms.

One of the interesting factors in this operation is that the pressure on the column is controlled to 45 psig by a valve on the plant fuel gas system accumulator vent. A small portion of this vented gas is ethylene, along with a large amount of inerts, most of which passes to fuel, but a portion goes to the gas holder from which the compressors take suction; in this way the percentage of inerts in the charge ethylene is held at the desired value for the best results.

Yields

According to engineers of the process, no reactants are lost via the "tar" route, therefore the percentage conversion is high. In an eleven-year period with 60,000-ton annual capacity, an average above 99.9 per cent pure ethylbenzene has been produced. Above 98 per cent of the benzene and ethylene fed to the process are recovered as either monoethyl or polyethylbenzene. The latter can be dealkylated, its components reprocessed in the same reactor as recycle, or may be processed as other products from the process.

One major problem, present always in any reaction which has variable equilibrium values, is that of raising the production rate of total alkylate while keeping to a minimum the polyethylbenzene formation. As ethylene ratio in the reaction mixture is increased by boosting the amount added to the stream, in order to increase the rate of alkylate formation, the benzene-ethylene ratio decreases, with the result that polyethylbenzene production is increased. To avoid this the benzene circulation rate is boosted.

Similarly, as catalyst activity is lowered by carbon "masking" (deposition) temperature of reaction is raised to maintain production rate. Beginning with fresh catalyst and maximum component, feed rate pressure drop across a given reaction tower rises in one unit, from an initial of 20 psig to 180 psig in 70 days, an increase caused by feed impurities decomposed to carbon which is deposited. To offset this problem outlet pressure of the reaction chambers is dropped with consequent reduction of alkylation rate. The answer to this appears to be purification of the feed streams. Much of the catalyst plugging occurs at the immediate entrance to the beds, and reversal of flow of reactants will extend the on-stream life of the catalyst by two weeks or more. Acetylenes and olefins should be removed from the charge, because especially acetylene decomposes easily into deposited carbon.

Aluminum Chloride Alkylation Process

This process offers both advantages and disadvantages over the high pressure process just described. In the Koppers Williams plant on the Texas Gulf Coast, now producing at a rate of more than 100,000,000 lb of ethylbenzene per year, reaction conditions vary widely from those employed in the high pressure process. As in the high pressure process impurities such as acetylenes, olefins, and sulfur, also water, are detrimental to the catalyst. Otherwise, the concentration of ethylene is not important, so long as the impurities are inerts, hydrogen, and paraffins. Nitration grade benzene, a high purity material, is satisfactory for this process.

Anhydrous aluminum chloride is the catalyst, with ethyl chloride as the promoter. With this catalyst the alkylation reaction is reversible, a fact that is taken advantage of by including polyethylbenzenes in the charge. This poly byproduct in combination with benzene reforms ethylbenzene which is included in the final product, while the poly forms are recycled to introduce the mass action effect in inhibiting formation of more poly product in the main reaction. The ethyl chloride introduces hydrochloric acid via side reactions, which is the actual promoter of the main catalyst. this side reaction forming HCl and ethylene and the latter taking part in the reaction.

The actual chemistry of aluminum chloride in promoting reactions between hydrocarbons and other organic chemicals is still not well understood. Friedel and Crafts, two English chemists, discovered the effect of $AlCl_3$ in reaction with organics. Since that time this amazing chemical has been used for cracking heavier oils (McAfee), for isomerization of hydrocarbons, for alkylation, the original discovery reaction, in a variety of types of operations. With hydrocarbons such as ethylene and benezene but also with many others, it forms an aluminum chloride-hydrocarbon addition product or complex, normally a dark, viscous oil, sparingly soluble in hydrocarbons from which it thus can be separated easily.

Increase of the percentage of ethylene in the reaction mixture decreases the amount of benzene, increases the ethylbenzene and polyethylbenzenes in the product, which is desirable for higher percentage of desirable product, but which promotes formation of higher hydrocarbons by combination or condensation, material that does not enter further in the main reaction, and thus is lost. In the Koppers operation, for example, the mol ratio of benzene in the mixture ranges between 1.5 and 2.5 to 1, which gives yields of 35 to 55 wt per cent of benzene, 30 to 50 per cent of ethylbenzene, and only 5-15 per cent of polyethylbenzens in the raw alkylate.

In the alkylators (reactors) in the aluminum chloride process, the benzene and aluminum chloride components flow countercurrent to the ethylene-ethyl chloride reactants and temperature is maintained at about 212 F, by the exothermic heat of reaction. Pressures are nominal (2-8 psig), and the mixture may be agitated by the incoming ethylene-ethyl chloride stream, or by introduction of natural gas.

While the ethylene reacts rapidly the mixture remains in the alkylator for 3-5 hours to reach approximate equilibrium. Overhead condensables are recovered and recycled.

Catalyst-hydrocarbon complex that is withdrawn with the raw alkylate is settled out, the alkylate is washed with water and then with mild caustic soda solution of say, 5-20 per cent. The neutralized raw product is sent to a series of columns from the first of which recycle benzene is recovered overhead. Ethylbenzene is taken overhead from the benzene column bottoms in a second tower, in which the problem of mono- and diethylbenzene separation is difficult, and small amounts of other impurities complicate the problem. In a third column the polyethylbenzenes, especially the di- and triethylbenzenes, are separated from inert heavy hydrocarbons to keep the latter out of recycle. This column operates at some 50 millimeters absolute pressure and the overhead product is sent to recycle in the process if the secondary-butyl benzene byproduct impurity is low enough in the stream.

Critical points in the process are the need to hold water content of the reactant stream as low as possible, to reduce catalyst consumption and to hold down sludge and corrosion. The benzene stream must be kept low in paraffins, since they affect efficiency and reduce capacity, also complicate dehydration of the benzene prior to its reaching the alkylators. Operations to date indicate that the overall efficiency of the process is more than 95 per cent on the charge materials. Aluminum chloride is used up at about 1 lb per 100 lb of ethylbenzene made, and ethyl chloride is dissipated at about half that rate.

The aluminum chloride process effects dealkylation, saving both benzene and ethylene, and requires lower benzene-ethylene ratios for efficient reaction rates, and requires no heavy, expensive pressure equipment. It is disadvantageous in that its corrosion requires more expensive alloys and materials, shows higher catalyst consumption, and the reaction is extremely sensitive to water. requiring careful dehydration of the reactants.

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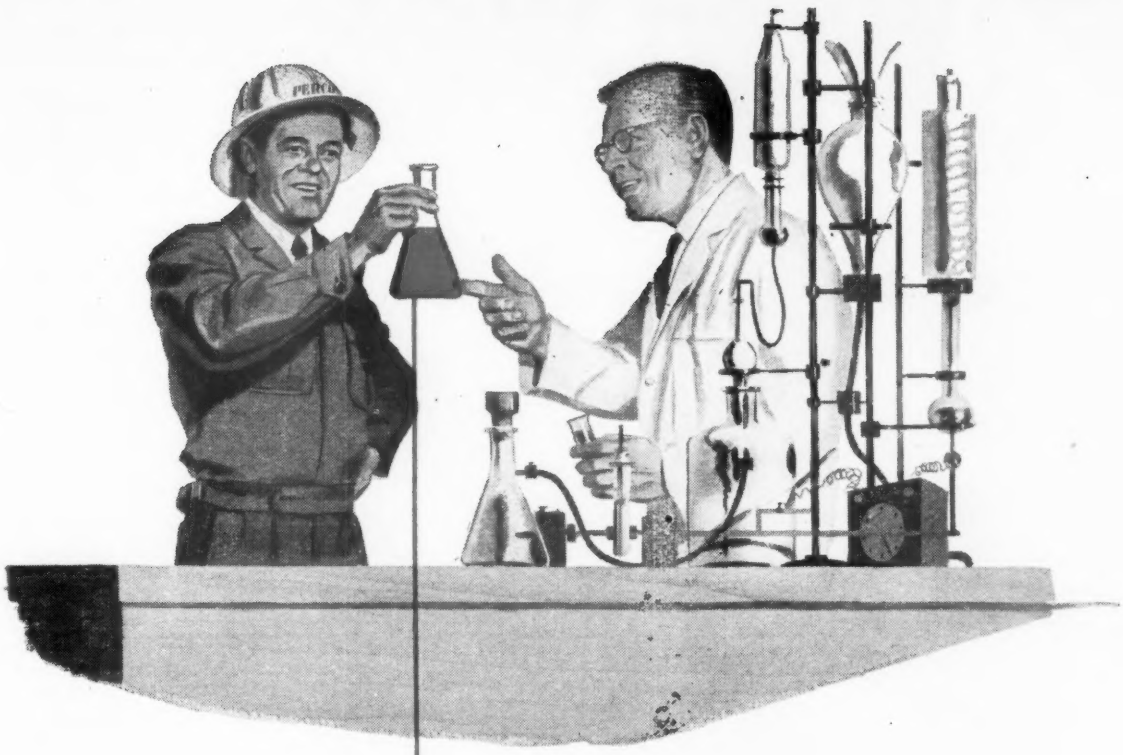
*Most of the data in this condensed article are taken from "Ethylbenzene as a Major Petrochemical," by F. R. Garner and R. L. Iverson, The Koppers Company, presented before the American Chemical Society, Chicago, September 6-11, 1953. ★ ★ ★



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Aerial view of British-American's Edmonton plant.

New Cat Cracker for Edmonton Refinery

Average throughput 27 per cent over original design capacity; maximum of 7000 bbl a day attained

E. E. SORENSEN*

WITH the great development in crude reserves that has taken place in Alberta since the war, it became obvious that refinery expansion was urgently required there for British American Oil Company Ltd.

The company's closest refinery, at Calgary, was not able to cope with the growing needs of the rapidly expanding industrialization in the Western Provinces. As a a result of economic studies it was decided that the best location for new facilities would be Edmonton, close to the newly opened Redwater and Leduc Oil fields.

The site chosen was approximately seven miles east of Edmonton, close to the Saskatchewan River and in proximity to both transcontinental Canadian railway lines.

*Manufacturing Department, British American Oil Company, Ltd.

"Low First-Cost" Design

The 5200 bbl per day combination plant, designed by the M. W. Kellogg Company, was based on a policy of low first cost. An integrated combination plant best satisfied this requirement, drawing on the highly skilled manpower needed to operate such a refinery from British American Oil's plants across Canada.

Canadia Kellogg Company, Limited, undertook the procurement and erection of the complete unit early in 1950. In May of that year, field construction was begun; in June 1951 the refinery was ready to go on stream. Operation has been highly successful ever since.

Severe problems arose during construction, because of the low winter temperatures and extreme weather conditions. Frost line is at an average depth of 4 ft, but safety calls for a minimum cover of 7 ft for foundations and water lines. Ice thickness on the river reaches 40 in., although water temperature goes up to 74 F during the summer.

EXCLUSIVE

Product Needs Surveyed

To establish the type of process sequence best fitted for the plant, it was necessary to study the crude available and the products required.

The main source of crude is Redwater, a 34 deg API crude of the following analysis:

IBP Per Cent	ASTM Distillation
IBP, Per Cent	118
10	227
30	395
50	578

Average salt content was about 35 lb per 1000 bbl. Sulfur is in the order of 0.5 per cent. Crude is brought in by pipe line from nearby fields.

At the time of design it was noted that very little or no demand existed for No. 2 fuel oil or bunker in these Western Provinces where cheap natural gas and coal exist in quantity.

Bunker Held to Minimum

The refinery, therefore, had to be a white products refinery, where bunker could be held to a minimum. Sufficient flexibility was also required in case a future bunker market should develop. To be able to reduce heavy fuel oil to a minimum it was decided to employ delayed coking.

Another consideration for the delayed coker was the fact that a ready market existed for this coke in the reduction of aluminum and other metallurgical industries in Canada.

A very high percentage of demand on white products consisted of gasoline of both high and low octane levels. To meet high octanes a catalytic cracking unit was found necessary and due to fairly large demand of medium octane gasoline, part of the cracking could be done thermally.

Demand for specialty products, including lighting naphtha, solvent, kerosine and tractor fuel, totaled less than 5 per cent of total white, but because stringent quality requirements existed it was necessary to build into the plant many facilities to cover these requirements.

A relatively high demand existed for diesel (about 13 per cent of total white) which had to meet difficult specifications for winter grades (—25 F max pour point). This was overcome partly through the fact that Redwater crude has an inherently low pour point, and partly through taking a very light cut.

Process Sequence

The sequence found best adapted to requirements set out above was a 5200 bbl per day completely integrated plant, including de-salting, topping, delayed coking, thermal cracking, catalytic cracking, and attendant combination recovery and stabilization facilities. (See process flow diagram on following page.)

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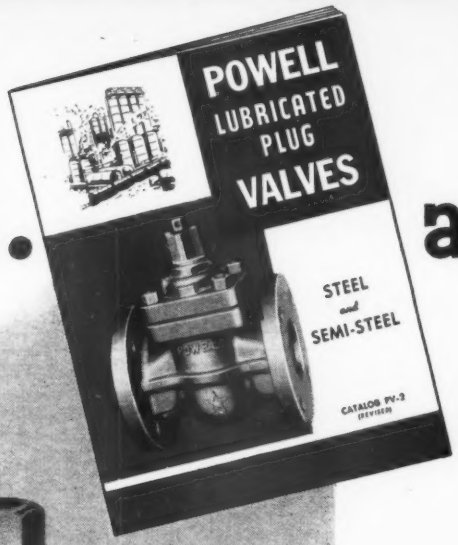

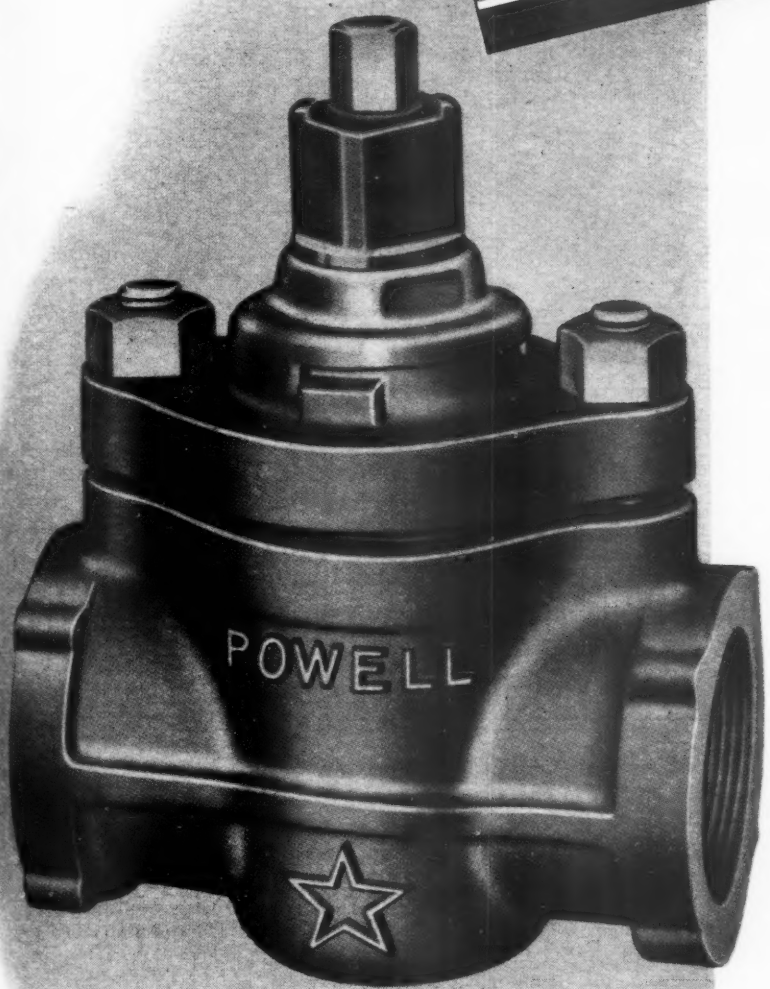

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It will be noted that after the desalting and topping steps, three main strategic lines of flow exist:

1. Light oils to thermal unit
2. Heavy oils to catalytic cracking
3. Residual crude to coker

Before arriving at these stages the crude is preheated to 200 F by a steam heater and reflux exchange before being desalted in a Petreco electrical de-salter. This operation brings the salt content down to an average 4-5 lb per 1000 bbl. The crude is further heated by exchange and in a tube still, and from topping operation the following products are withdrawn:

1. Lt. virgin naphtha
2. Solvent
3. Kerosine
4. Diesel
5. Heavy gas oil
6. Reduced crude

The straight run naphtha is caustic washed and treated before blending. Solvent is caustic-washed and sent to storage. Kerosine cut goes to (a) storage, as such, after caustic-wash, (b) is blended with diesel cuts to produce specification diesel, (c) excess kerosine is thermally cracked. Diesel cut goes to storage, as such, after a caustic wash. Excess diesel fuel is thermally cracked.

Both for excess kerosine and diesel an alternate sequence may be used. They may be switched in as part of direct feed to the cat cracker if desired. Heavy virgin gas-oil goes to the cat cracker.

Gas Oil Cracking and Delayed Coking

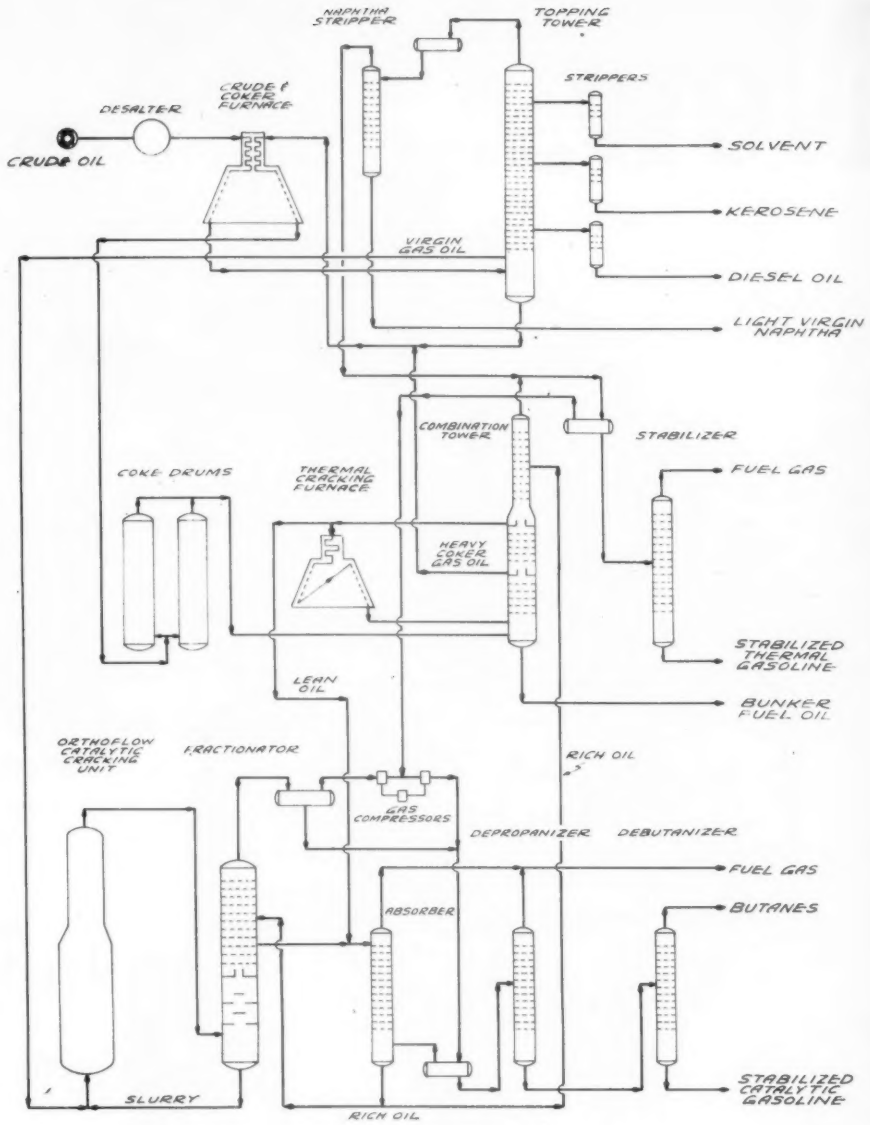
Reduced crude enters the combination crude and coker-furnace and thence to one of the two coke-drums, where a switch valve directs it to whichever drum is being used at the time. After filling one drum with coke, the oil is switched to the other drum and the coke is removed by means of the Hughes decoking system, which cuts out the coke mechanically.

Effluent vapors from the top of the coke-drum go to the flash section of the combination tower and here join thermal cracker effluent.

Tar resulting from both thermal and coking operations can be recycled to coker, or is sent to product storage as bunker fuel.

Initially, operations called for sending heavy coker gas oil to the cat cracker, but at the present time this is recycled to extinction in the coker, thus limiting the cat cracker feed to virgin stocks. The reason for this change lies in an improved gasoline and coke yield obtainable from the cat cracker when excluding heavy coker gas oil. It is, however, open to doubt that gas oil from coker is responsible, because some thermally cracker material from thermal cracker is contained in this so-called coker gas oil.

The light gas oil emerging from the combination tower represents in the main the breakdown products from the coking unit. This stream is used as lean oil for the absorber in the common recovery plants, as quench for the thermal cracker and for reflux duties. This gas oil is eventually cracked in the thermal cracker, with the rest of the feed, consisting of light cycle oil from cat cracker, excess kerosine, and diesel.



Flowchart of British-American Oil's Edmonton refinery, with new Orthoflow cat cracker in operation.

Rich oil from the absorber, consisting originally of light catalytic cycle oil and light coker gas oil is returned to the combination tower.

Overhead vapors of the combination tower consist of:

1. Coker gasoline and gas.
2. Thermal cracker gasoline and gas.
3. Absorbed gas stripped from rich oil.

Overhead gasoline is stabilized in the thermal gasoline stabilizer, cooled, caustic washed, and sent to storage.

Catalytic Cracking

The cat cracker is of Orthoflow design, a development of the M. W. Kellogg Company. The design provides for minimum erosion from catalyst flow combined with compactness and minimum first cost.

The feed consists of:

1. Heavy virgin gas oil
2. Diesel or kerosine (optional)

The effluent is fractionated into the following components:

a. Gas
b. Gasoline
c. Light cycle oil

All heavy gas oil is recycled to extinction.

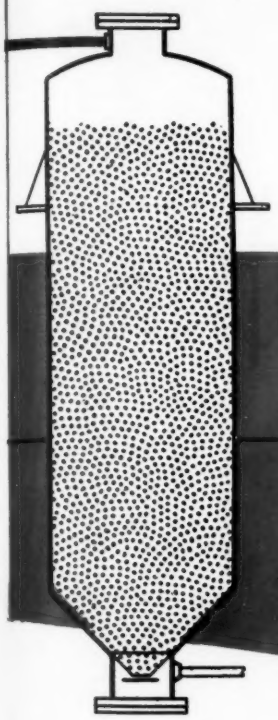
Overhead gasoline is depropanized in separate stabilizer; wet gas going to absorber and then being pumped to a debutanizer, where excess butanes are removed in adjusting the vapor pressure. It is then caustic washed and sent to storage.

Comprehensive Training Requisite

Due to the fairly high sulfur content characteristics of gasoline and distillates, comprehensive treating facilities are required.

Besides caustic-washing most light streams, the refinery incorporates the following treating facilities:

1. For light virgin naphtha
   a. Salt drier



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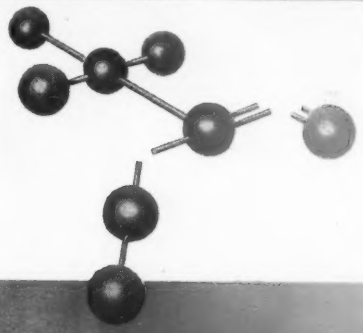

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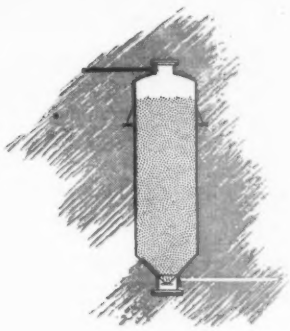

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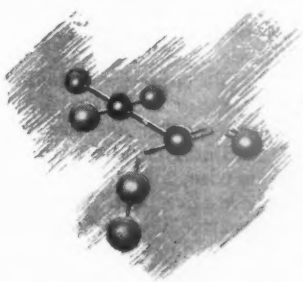

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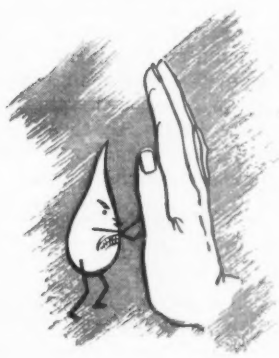

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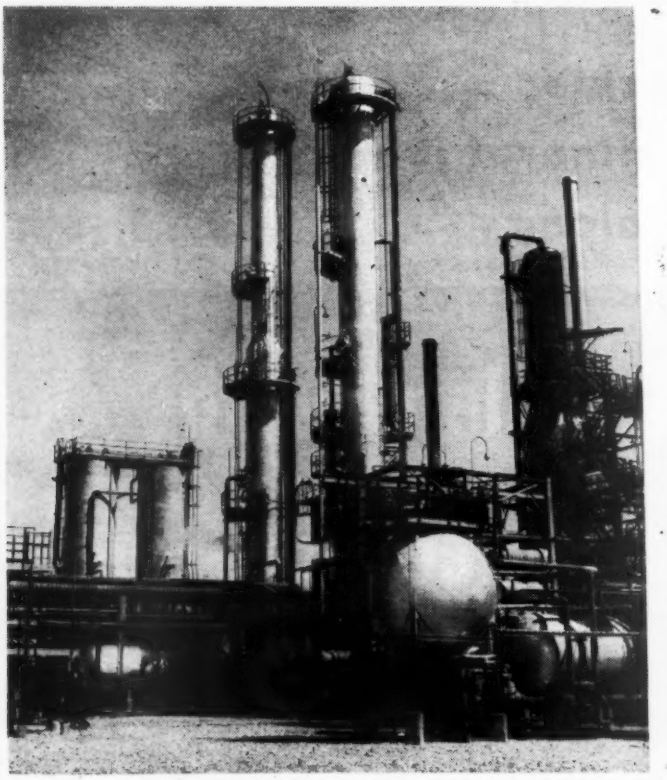
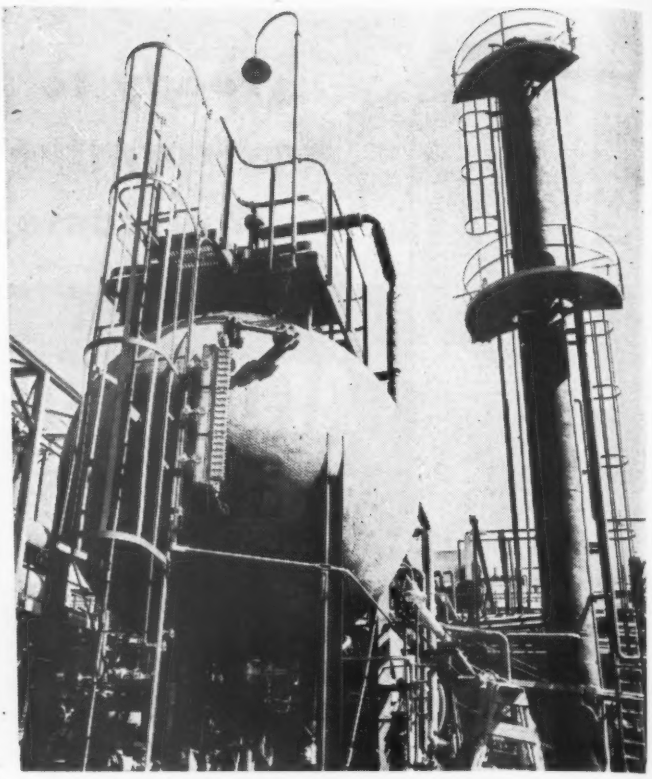


Combination tower and crude tower are shown in center, Orthoflow cat cracker converter in rear (right), with desalter equipment in right foreground.



Edmonton plant's crude desalter sphere is shown in foreground with desalter surge drum just beyond, and thermal gasoline stabilizer at right.

b. Copper chloride contract treatment
c. Clay treater

2. For kerosine and solvents
   a. Clay treater
   b. Salt drier
   c. Acid wash (2 stages)
   d. Caustic wash
3. For thermal gasoline
   a. Salt drier
   b. Linde copper sweetening
   c. Inhibitor addition
4. For cat cracker gasoline
   Inhibitor addition

To summarize, all the operations described above have been integrated into a combination refinery wherein, as has already been indicated, certain process steps share common pieces of equipment. In many cases, oil streams flow hot from one step to the next without passing through coolers or intermediate storage, and at several points there is heat exchange between streams in different process stages. By these devices, savings have been effected in both initial investment and operating costs.

Yields

Overall yields obtained during 1952 are shown in Table 1.

Time efficiency on the integrated plant was about 91 per cent, giving an average throughput per stream day of 6600 bbl or close to 27 per cent over the design figure of 5200 bbl per day.

Maximum throughputs of more than 7000 bbl per day have been attained easily and can be sustained for lengthy periods for both Redwater and Leduc crudes.

Above yields differ in following aspects from design:

1. Production of all products are above design.
2. A local market for bunker has been found.

No better picture could be shown to illustrate the immense expansion that the Canadian west is going through. To further satisfy the ever-growing demand for petroleum products there, it is felt that further expansion of facilities probably will be required.

Offsite Facilities

Engineering and purchasing on offsite facilities were done by British American Oil's engineering and purchasing departments.

Overall general construction was carried out by W. M. Barnes Company of Canada, Ltd., Toronto, with the exception of the administration building, which was constructed by Burns and Dutton Concrete and Construction Company, Ltd., Calgary.

TABLE 1. Overall yields in 1952.

	Barrels	Percent on crude	Percent on all white
Motor gasoline	1,253,000	57.6	79.9
Solvents and turbofuel	26,000	1.2	1.6
Total gasoline and solvents	1,279,000	58.8	81.5
Kerosine	16,000	0.7	1.0
Tractor fuel	39,000	1.8	2.5
Diesel	235,000	10.8	15.0
Total heavy white products	290,000	13.3	18.5
Total all white products	1,569,000	72.1	100.0
Bunker	261,000	12.0	
Liquid refined fuel	24,000	1.1	
Miscellaneous unfinished product	2,000	0.1	
Total liquid yield	1,852,000	85.1	
Gas and coke loss	325,000	14.9	
Crude	2,177,000	100.0	
Coke (Tons)	22,734		

Because crude is brought in by pipe line and also because operation of the refinery is highly integrated, requiring no intermediate storage, it was possible to save much on capital outlay for tankage. Tankage amounted to 480,000 bbl and was erected by Horton Steel Works Ltd., Montreal.

Steam generation equipment was obtained from Foster-Wheeler Ltd., St. Catherines, Ontario (120,000 lb of steam per hour). Again a substantial saving here is possible through combination features of the plant.

The refinery is equipped with mechanical foam facilities for fire-fighting.

Cooling water towers were erected by the Fluor Corporation, Los Angeles.

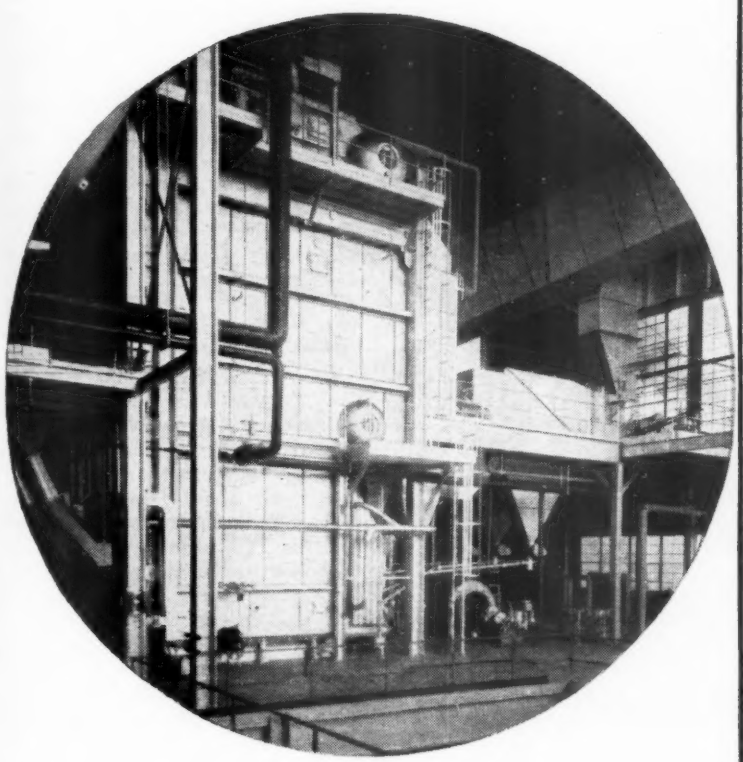
The cooling water system presented some unusual problems. The Saskatchewan River is flanked by steep banks. During the spring thaw water levels will rise as much at 25 ft. Two intake lines run into the river which is 7800 ft from the refinery and 250 ft below the refinery elevation. These intake lines go into the river for a distance of 300 ft and are anchored to the river bed with concrete. The lines lead up to the deep well pumphouse, where two 125 hp Layne vertical pump units, each rated at 1250 USGPM against a total head of 300 ft, discharge to cooling ponds in the refinery area.

The plant site covers 160 acres. Total cost of plant was $7,800,000, and requires a staff of 150 employees. * *

XUM

City of Manitowoc installs fifth WICKES steam generator

To provide a dependable source of power for the City of Manitowoc, Wisconsin, the Manitowoc Public Utilities Commission has just installed a fifth WICKES Steam Generator capable of producing 175,000 lbs. of steam per hour at 525 psi. Final steam temperature is 750°F. The new WICKES Boiler has 11,600 sq. ft. of heating surface. It is equipped with an economizer and fired by spreader stoker.



R. E. Cannard — Chief Engineer and General Manager

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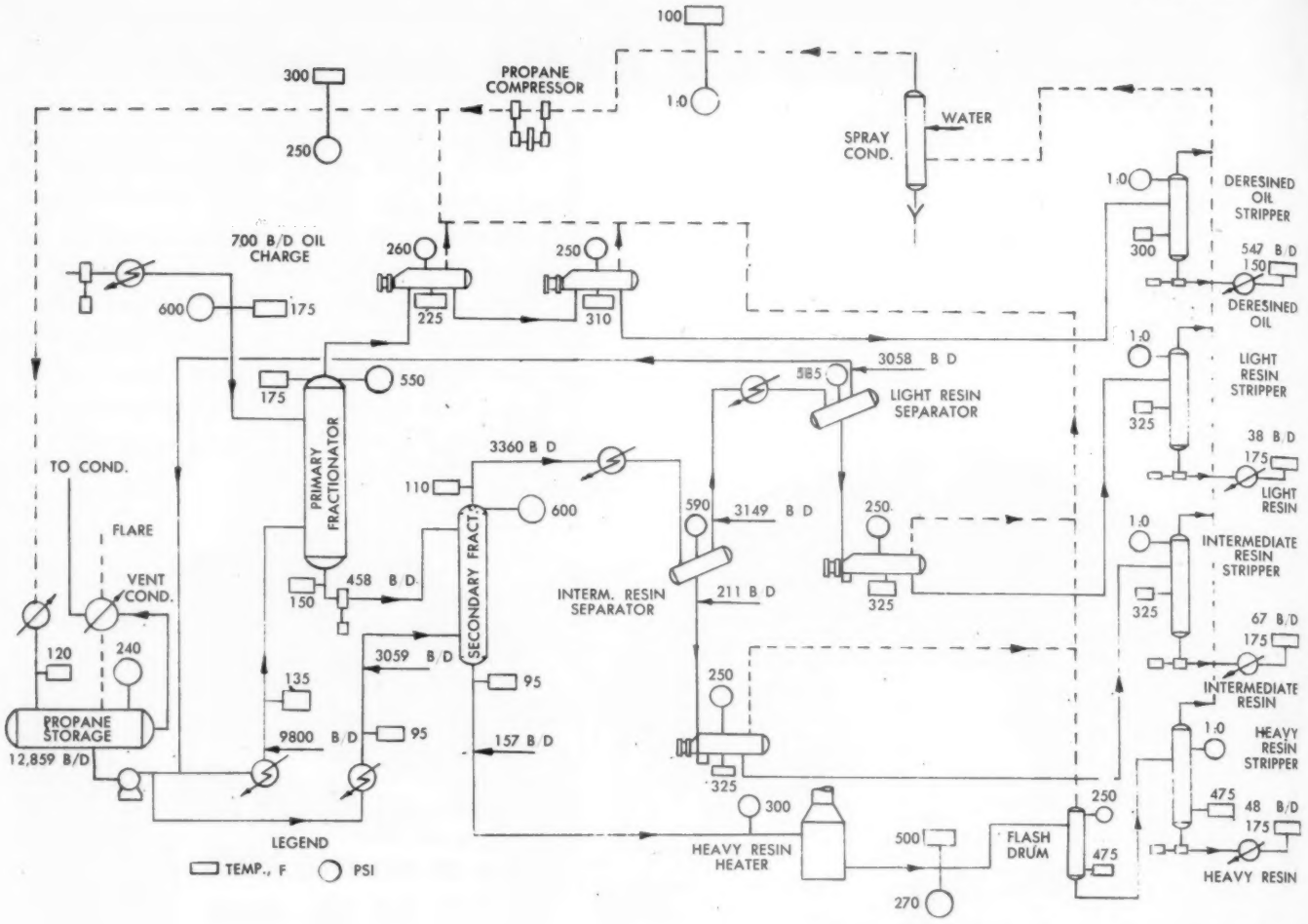


FIG. 1. Flow-chart for propane deresining unit.

Propane Fractionator on Stream at Wellsville, New York

Two-stage tower design and separators make deresined bright stock and oil-free resins

E. B. BRIEN*

A NEW unit to treat Pennsylvania cylinder stock by propane fractionation was recently put on stream by the Sinclair Refining Company at Wellsville, New York. Designed for a minimum capacity of 700 bpsd, the unit economically produces deresined bright stock of good color and low carbon content for use in premium motor oils and various grades of resins.

Basic equipment in the new plant consists of primary and secondary fractionating towers, light and intermediate resin separators, heavy resin heater and flash drum, propane compressor and storage tank, and associated reboilers, exchangers, strippers and pumps. (Fig. 1).

The two-stage tower design and resin separators make for a highly flexible plant that can treat as much as 1000 bbl of light reduced crude per day. (Fig. 2). It also permits a diversified production of various types of resins, as seen in Table 1.

EXCLUSIVE

Propane as a Solvent

Purpose of fractionating oil in a liquid solvent, such as propane, is to separate undesirable resinous and asphaltic fractions, and thus to produce a high quality oil. Heavy hydrocarbons tend to increase carbon deposition and instability of oil in service.

Light, liquid hydrocarbons have the characteristic of holding oil in solution and precipitating heavy fractions in inverse relation to their molecular weights: The lower the molecular weight of the solvent, the higher the separa-

*Eastern Editor.

tion of the high molecular weight fractions in petroleum.

Propane is generally preferred over the other lighter hydrocarbons because the latter require very high pressure equipment to keep them in the liquid state and are, therefore, expensive to use. Propane also gives a better separation of the oily from the resinous fractions than do other hydrocarbons.

For the purpose of the propane fractionating process, resins are defined as those components that are rejected from the solution; oil, as those components that are kept in the solution.

The process exhibits certain definite characteristics worthy of note:

The higher the temperature in the process, the lower is the solubility of the oil and the greater is the yield of heavy fractions; the higher the temperature in the top of the fractionator, the lower is the yield, viscosity, carbon residue, and the lighter the color of deresined oil; the higher the ratio of propane to oil, the greater is solubility of the oil and the higher is the yield, viscosity, carbon residue, and the darker the color of deresined oil; the more resins precipitated, the lower is the viscosity of the oil and the lower viscosity of the resins.

Actual Plant Operation

Actual operation of the Wellsville plant proceeds as follows:

Charge Oil: Cylinder stock piped in from the crude still is fed at the rate of 700 bbl per day to the primary fractionator, a tower 7 ft in diameter and 37 ft high, through the feed inlet 11 ft from the top of the tower. (Fig. 3). Heated under instrument controlled steam to 175 F through coils above the oil feed distributor, the charge oil flows down to mix with liquid propane rising from the bottom of the tower. Good mixing of both charges is provided for by the counter-current flow of the liquids and 24 baffles of subway grating over most of the tower. Resins present in the oil precipitate to the bottom of the tower. The deresined oil, about 79 per cent of the charge, with a major portion of the propane, flows out of the top of the fractionator under pressure control.

Propane Charge: The primary tower is designed to receive 14 volumes of propane at the propane inlet 3 ft from the bottom of the fractionator for each volume of charge oil at the top. Fresh propane, stored in a 20,000-gal drum, is supplemented by recycle propane from the light resin separator. These two streams are fed in at the rate of 9800 bbl per day.

Operating range of charge oil and propane can be varied greatly according to the feed stock or intents of the operators. Usually, an increase in propane ratio increases viscosity of the bottoms product and at the same time possibly increases viscosity and color of the overhead deresined oil.

In order to keep the propane as a liquid, pressures in both the primary and secondary towers are held at 550 psig.

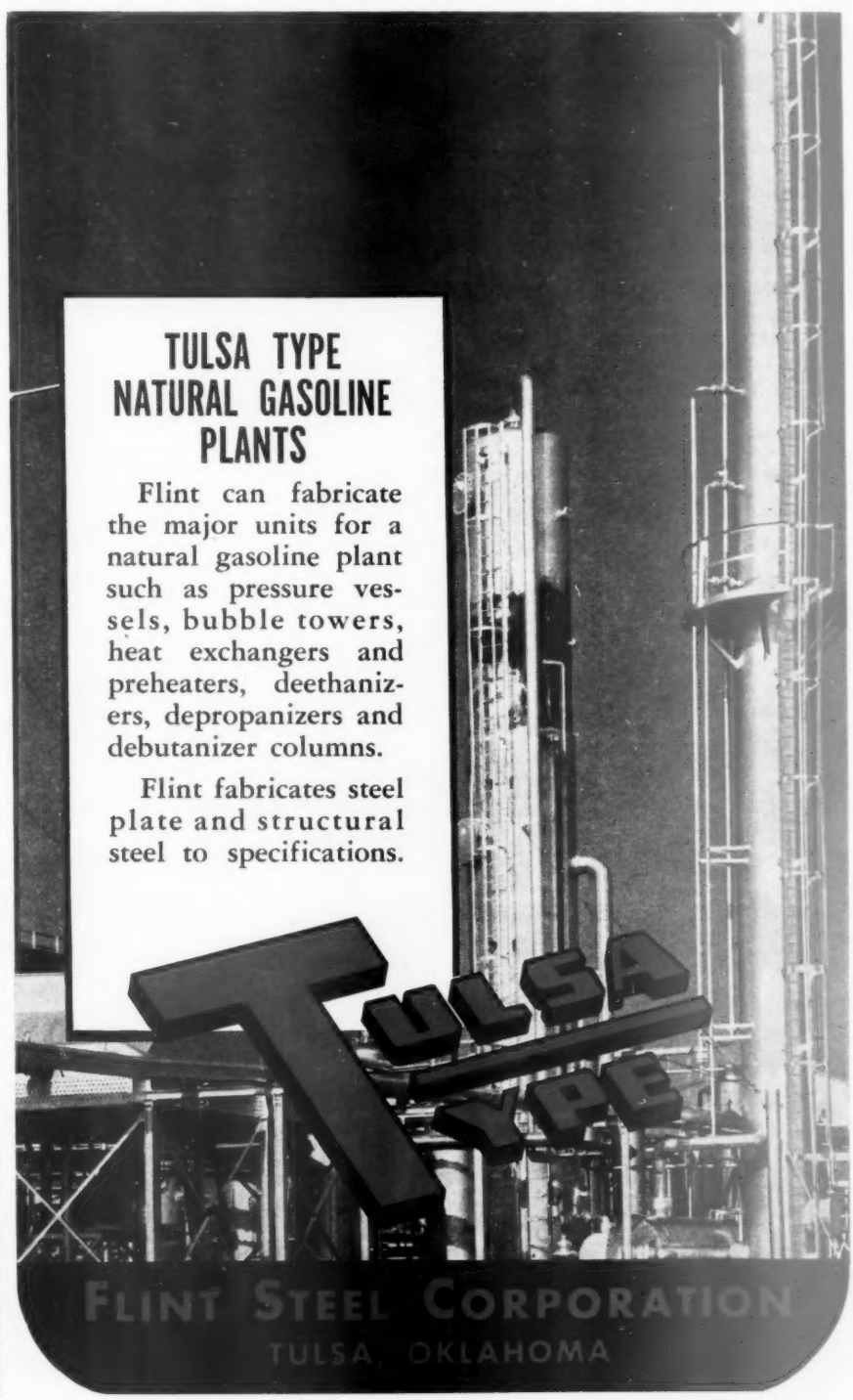
Quality and quantity of deresined oil are determined at this stage in the primary fractionator. The resins, separated as bottoms, are split into three fractions and their qualities are determined in the secondary fractionator and the following separators.

TABLE 1. Yields, per cents and composition.

Stream	BPSD	Volume per cent	Gravity API	Flash F (CCC)	Vis 210 F Saybolt	Carbon residue	Color NPA
Operation 1							
Cyl. stock charge	700	100.0	24.1	600	240	3.3	...
Deresined oil	547	78.0	26.0	575	142	1.4	6+
Light resin	38	5.5	21.7	660	500	3.9	...
Heavy resin	115	16.5	16.3	680	3,100	12.7	...
Operation 2							
Cyl. stock charge	700	100.0	24.1	600	240	3.3	...
Deresined oil	547	78.0	26.0	575	142	1.4	6+
Light resin	38	5.5	21.7	660	500	3.9	...
Intermediate resin	67	9.5	20.0	670	1,020	6.5	...
Heavy resin	48	7.0	14.5	...	10,000	....	...

Temperatures: Quality of the deresined oils and the resins is determined in the primary fractionator by three sets of temperatures.

Top tower temperature is controlled by steam coils at the top of the tower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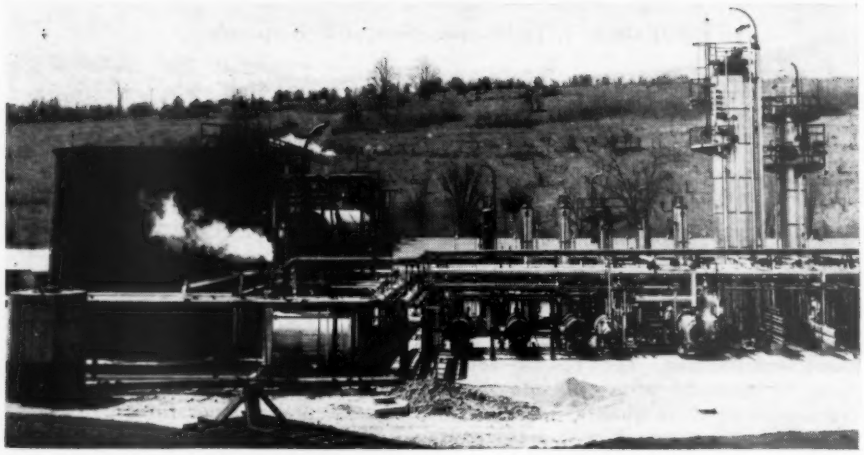


FIG. 2. DERESINING unit at Wellsville, New York, has 700 bbl per day capacity.

and is most critical in the entire plant—a 1 F variation markedly changes quality. Increasing top temperature, all other conditions being equal, produces a lower viscosity, a lower carbon residue and a lighter color on the overhead product, and lower viscosity in bottoms product. Decreasing top temperatures reverses the characteristic of both tops and bottoms.

Bottom temperature is governed by a recording controller immediately before the primary heater ahead of the propane inlet.

Feed zone temperature is controlled more by top tower temperature than by that of the rising propane. The temperature gradient in the tower produces an internal refluxing for improved fractionation of the charge oil. The higher top temperature forces the charge oil to the bottom; the lower bottom temperature and the up-going propane force the material back up to the top. Through this internal refluxing, the desired fractionation takes place. As in the bubble tower, that section of the tower between the oil inlet and the top is the rectifying zone; that below the feed zone is the stripping zone.

Recovery of Deresined Oil: Under tower pressure, the charge oil, freed of resins, flows out of the top of the primary fractionator with a major portion of the propane to the primary evaporator, a horizontal vessel 4 ft in diameter by 23 ft 11 in. long. The evaporator is held at 200-225 F by low pressure steam; lower temperatures induce foaming and put an additional load on the other deresined oil vessels. Upstream pressure in this vessel is the same as in the tower, 550 psig, and downstream pressure is 275 psig. The 275 psig drop allows part of the propane to flash with a consequent drop of 30-40 F. The deresined oil is then heated to 325 F and is passed to the secondary evaporator, a horizontal vessel 15 ft 4 in. long and 3 ft in diameter, where it loses more propane. Through level control, the deresined oil moves on to the stripper, which is equipped with a mist extractor to minimize carry-over of oil with propane vapors, where the remaining propane is stripped. The bottoms, now entirely free of propane, are cooled and pumped to storage for MEK dewaxing. (Fig. 4).

Heavy Resins Recovery

With a top temperature of 175 F and a bottom temperature of 150 F, primary fractionator precipitates a bottoms product of all the resins originally present in the feed stock. The bottoms product amounts to 21 per cent on cylinder stock charged. At this stage, the bottoms solution consists of equal parts of resin and propane and is to be further separated into heavy, intermediate and light resins.

Primary tower bottoms are pumped under flow control into the top of the secondary fractionator, a vessel standing 20 ft high and 44 in. in diameter, where the heaviest resins are separated. In this tower, the solution flows down to mix with rising propane at a ratio of 1 volume of resin to 20 of propane. The secondary tower is operated in the same way as the first tower, except that operating temperatures are much lower.

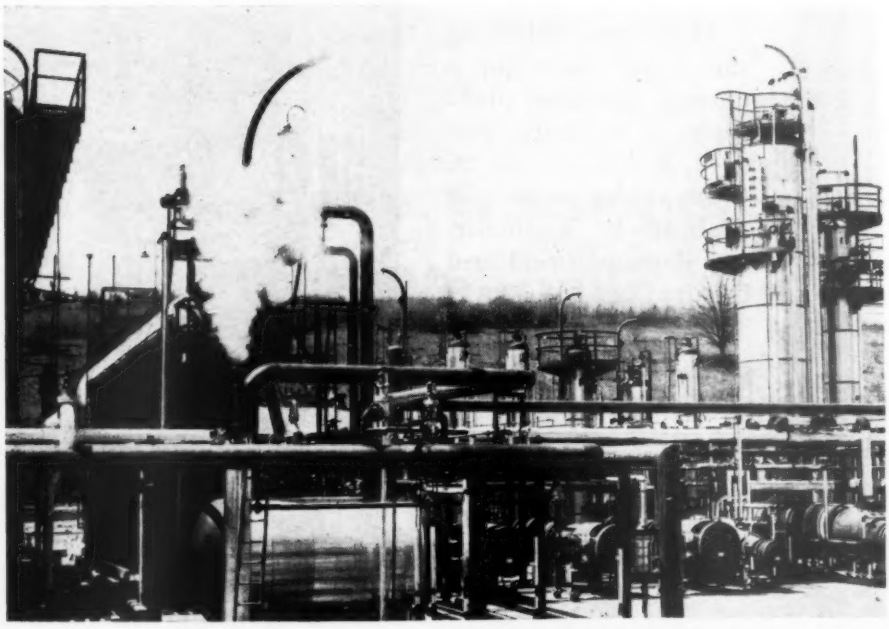


FIG. 4. ALL OPERATING lines are overhead; silver blow-down drum at left with condensers and evaporators are at right center foreground.

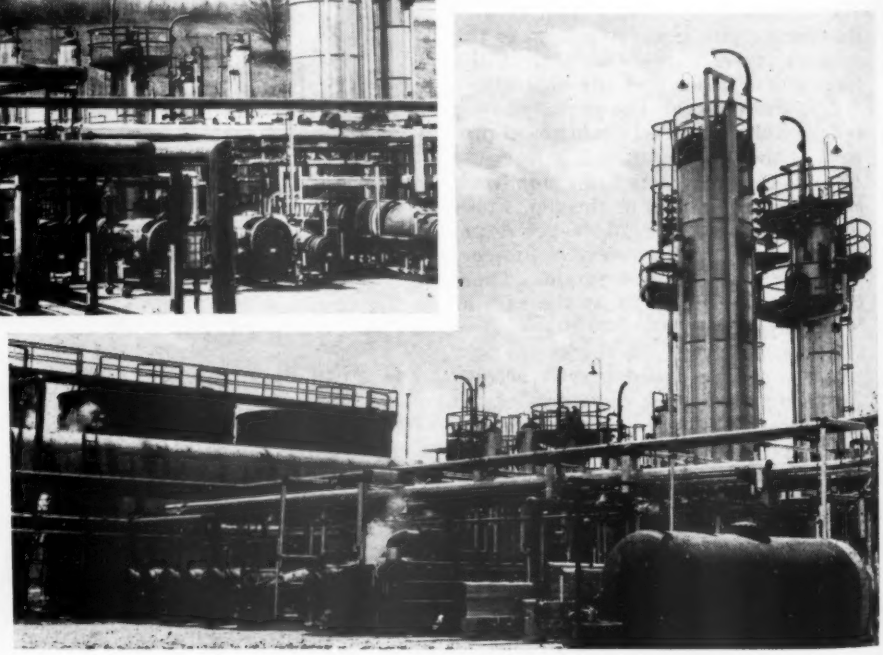


FIG. 3. PRIMARY and secondary fractionating towers treat cylinder stock stored in left background tanks.

Top temperature in the secondary fractionator is maintained at 110 F through coils using low pressure steam; bottom temperature—that of the propane—is reduced to 95 F. These relatively low temperatures permit more resins to become soluble in the propane and thus passes out from the top of the tower. Only the heaviest resins remain insoluble and precipitate to the bottom.

Bottoms of Secondary Tower: The lower phase in the secondary tower containing the heaviest resin fractions with about an equal part of propane moves under tower pressure and flow control to the heavy resin recovery system. The resin-propane solution is heated to 475 F in a gas-fired heater and then passed to the heavy resin flash drum where a major portion of the propane is vaporized. The remaining solution then flows through the mist extractor in the top of the vessel in order to minimize resin carry-over and to coolers for condensing.

Bottoms in the flash drum still contain a small amount of propane. Under level control this solution moves to the heavy resin strippers, a column 13 ft 8 in. high and 20 in. in diameter, where the remaining propane is flashed. and the residual oil is stream-stripped with high pressure steam.

The propane and water vapors leave the top of the stripper through the header common to all the strippers and thence to the jet condenser. Under level control the propane-free bottoms are

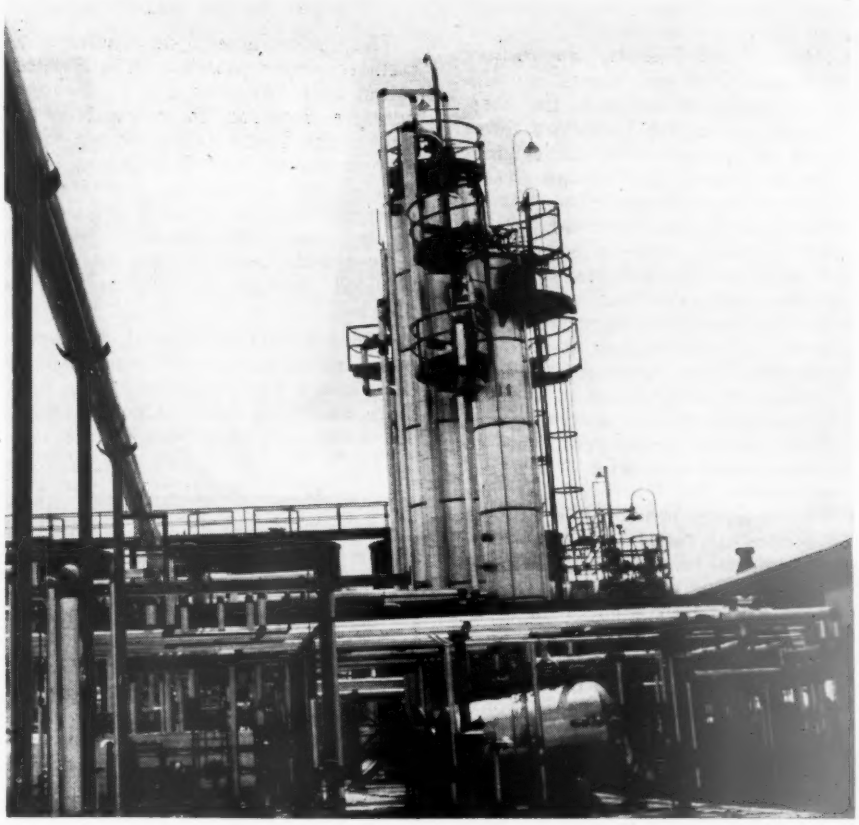
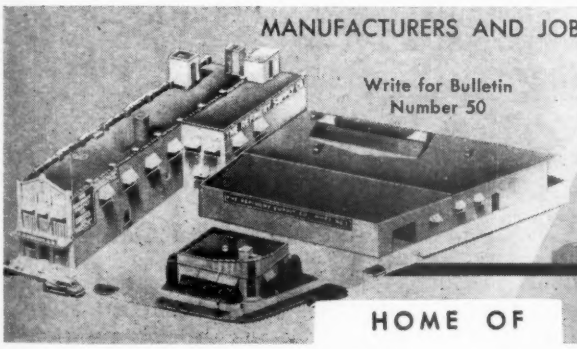


FIG. 5. LARGE blow-down line to flare is at left; slanted tank is intermediate resin separator.



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pumped to the heavy resin cooler and out to storage.

Intermediate Resins, Secondary Fractionator Overhead: Consistent with the low operating pressure, the overhead stream from the secondary tower contains all the resins in the original charge oil except the heaviest resins precipitated in the bottom phase. Under tower pressure this overhead stream flows to a heater, where it is raised to 140 F with low pressure steam. Throttling the condensate out of the exchanger regulates the temperature.

The heated solution then flows to the intermediate resin separator, a horizontal vessel 8 ft long by 44 in. in diameter. Because of the increased temperature, the heavier resins precipitate to form a two-phase separation. The upper phase contains the light resin fractions and the lower, the heavier; the latter is the intermediate resin. (Fig. 5).

On interfacial level control, the lower phase flows to the intermediate resin evaporator, a vessel similar to the separator. High pressure steam in the tubes holds temperatures at 325 F. Propane vapors pass on overhead to coolers and to storage for recirculation.

The remaining liquid flows to the intermediate resin stripper, a vessel 13 ft 8 in. high and 20 in. in diameter, where the water and propane vapors pass overhead to the jet condenser. The propane-free material at the bottom is pumped on level control to a cooler and from there to tankage.

Light Resins Recovery

The upper phase in the intermediate resin separator passes overhead and is raised in a heater to 190 F, the temperature required to precipitate the light resins. In the light resin separator, a horizontal vessel 8 ft long and 44 in. in diameter, a majority of the resins precipitate out as a lower phase. The upper phase, substantially propane, merges with fresh propane feed to be recycled through the primary fractionator.

Under interfacial control, the lower phase material in the separator flows to the light resin evaporator and from there to the coolers for condensation. The bottoms product flows on level control to the stripper where stripping steam removes the remaining propane. The propane-free bottoms are then pumped on level control to the light resin cooler and to tankage.

East Coast Refinery

Pan American Refining Corporation will build its proposed new East Coast refinery in Goodwin Neck, York County, Virginia, it was announced by L. William Moore, president.

Present plans call for commencement of construction within six months, with completion of the refinery scheduled for late 1955. Initial refining capacity will be 25,000 bbl per day.

Propane Recovery System

All overhead vapor streams from stripping towers merge and pass under low pressure to a jet condenser, a vertical vessel 13 ft high and 2 ft in diameter. They enter this tower above water level but under the baffles and move upward. Water enters the tower above the baffles and flows downward. The counter-current mixing of the two streams condenses the water vapors and cools the propane vapors to about 100 F. The water is withdrawn from the tower under flow control, while the cooled propane vapors pass overhead to a secondary trap where entrained water is removed. The propane vapors pass to a compressor where pressure is increased to a point which insures condensation in the coolers.

Propane vapors from the evaporators, the heavy resin flash drum and the compressor-discharge merge under high pressure to enter the knockout drum, designed to trap resin-carryover. Resin would foul the tubes in the propane cooler were it permitted to enter. Propane vapors are finally condensed, cooled and returned to storage for recycling.

Wellsville plant was constructed by Fluor Corporation of Los Angeles. * *

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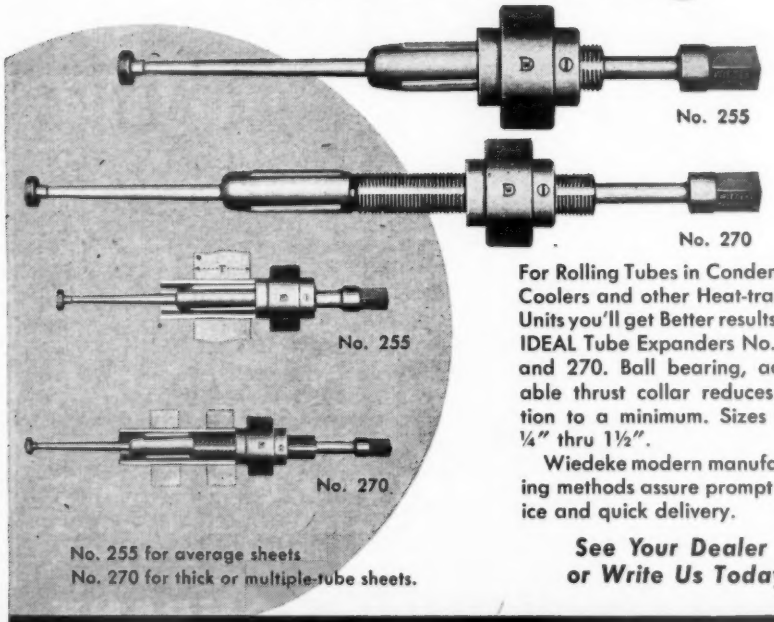

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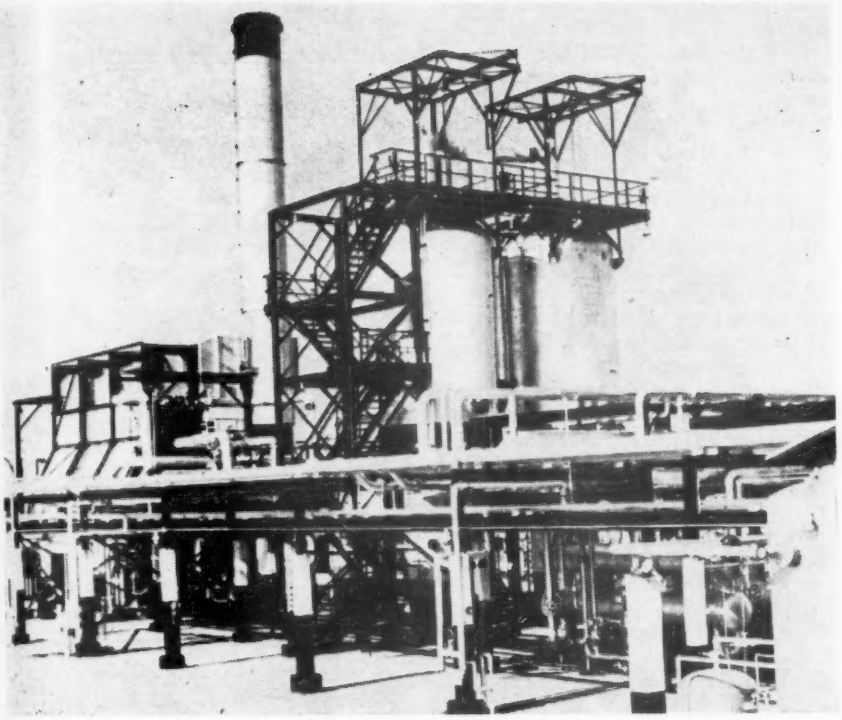

Cycloversion unit at Pemex Mexico City refinery.

Mexican Gasoline Desulfurized

Removal of up to 0.1 per cent sulfur raised maximum octane number 8 to 10 points

HARRY J. BURNS* and CARLOS L. CORCUERA†

PETROLEOS MEXICANOS (Pemex), the national oil company of Mexico, finds it convenient and profitable to desulfurize straight run gasoline and part of the thermally cracked gasoline in three of their largest refineries by use of the Cycloversion process.

The first of these Cycloversion units to be installed, under license from the Phillips Petroleum Company, was in the refinery at Salamanca in north-central Mexico, which started operating in August 1950. The second unit, at the Mexico City refinery, started on July 2, 1952. The third unit, situated in the Madero refinery at Tampico, went into operation in August 1952. Each of these units is designed for 12,000 bbl per day charge capacity. This paper will discuss the manner in which the Cycloversion unit was fitted into the processing plan of the Mexico City refinery, its operation and the results obtained. A view of the Mexico City unit is shown in the accompanying picture.

Pemex's Mexico City refinery, which was rebuilt in 1945, has two topping units with a total crude capacity of 55,000 bbl per day. Only 50,000 bbl per day is actually charged, however, as this is the maximum capacity of the pipe line that brings the oil over the mountains from the Poza Rica production area to Mexico City. In addition to the crude stills, the processing units are a two coil thermal cracking unit of 15,000 bbl per day capacity, an HF alkylation unit, an isomerization unit, light end fractionating facilities and the Cycloversion unit. The usual facilities for treating, blending, ethylizing, loading, etc., are also included in the large plant.

Straight run gasoline from the Poza Rica crude contains approximately 0.08 to 0.10 wt per cent sulfur. By removing the sulfur compounds from this gasoline, it was found that an octane improvement of 8 to 10 numbers could be obtained at the 3 ml TEL level. In harmony with its wish to give the motoring public an ever better quality product, Pemex found that the octane number improvement obtained by desulfurization made it much easier to supply the regular grade of gasoline (Mexolina) and at the same time provide larger quantities of premium gasoline (Super-Mexolina).

The Cycloversion unit equipment consists of two 12 ft by 26 ft 6-in. catalyst chambers, each containing approximately 80,000 lb of bauxite catalyst, a process heater, product to charge heat exchangers, a product accumulator, charge and product pumps, and catalyst regeneration facilities. The nominal capacity of 12,000 bbl per day has been exceeded most of the time since the unit went into operation; and occasionally a charge of over 17,000 bbl per day has been processed successfully.

Normal processing temperature at the inlet of the catalyst chamber is 800 F. Production of gas at this temperature is very low and at times the chamber effluent product is totally condensed. The amount of carbon deposited on the catalyst is very small and as much as 750,000 bbl has been processed through a chamber before catalyst regeneration was necessary.

The crude received in Mexico City contains approximately 28 per cent gasoline and lighter, as indicated in Table 1. Considerable light material, recovered in the absorption and stabilization plants in Poza Rica, is added to the crude before it is moved to the refinery, thus giving the Mexico City refinery an enriched synthetic crude carrying a far greater percentage of light material than other crudes in Mexico.

Gasoline and lighter material removed in the refinery topping units is collected in spheroid tanks. In the original processing plan, this material was charged to a depentanizing tower, with the pentane-free bottoms going to solid copper chloride treaters. Pentane and lighter overhead material was then charged to a depropanizer, where the propane and hydrogen sulfide were removed; the bottoms product was caustic washed, treated with dry copper chloride, and fractionated into iso and normal pentane, and fractionated into iso and normal butane, and iso and normal pentane.

It is interesting to note how easily the Cycloversion unit fitted into the described flow by making use of the existing depropanizer to remove the additional amount of hydrogen sulfide that was produced.

TABLE 1. Analysis of crude oil from the Poza Rica field.

Sulfur	1.86
Ash	0.011
Paraffin wax	4.260
NaCl lb 100 bbl	40.00
R.V.P.	10.6
BSW	0.1
Visc. SU at 18.9 C	74.0
Visc. SU at 21.1 C	71.0
Sp. gravity	0.843
Distillation	
I.B.P. C	31
Per cent at 185 C	24
Per cent at 200 C	27
Per cent at 265 C	36
Podbielniak analysis	
Ethane	Trace
Propane, per cent	0.8
Isobutane	1.0
Normal butane	3.9
Isopentane	1.8
Normal pentane	2.9
Hexanes plus	89.6

*Perco Division, Phillips Petroleum Company.
†Superintendent of Refineries, Petroleos Mexicanos.

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The raw straight-run gasoline from the spheroid tanks is now charged first to the Cycloversion unit, from which it goes directly to the depentanizing tower, thus requiring no additional storage. No other changes were necessary in the processing plan as described above, except of course, that after removal of the hydrogen sulfide in the depropanizer, all products are sweet and require no further treatment. The iso-butane is used in HF alkylation. Normal butane is used as charge stock for the isomerization unit and also as LPG. The iso-pentane goes into aviation gasoline blending. Normal pentane and heavier material is put into motor gasoline.

Because of the amount of light materials present in the charge to the Cycloversion unit, the improvement in octane number obtained on the motor fuel portion of the charge can best be shown by testing debutanized samples of the charge and product. Inspection tests of such samples are shown in Table 2, which indicates an improvement of 10 Research octane numbers at the 3 ml TEL level.

Desulfurization of straight run and cracked gasoline blends has been carried out on an experimental basis with very good results. As the unit is usually running at maximum capacity with the current production of straight run feed stock, however, it is not possible to include the cracked gasoline as a normal operation.

Good results have also been obtained from some experimental reforming runs on straight run stocks at higher temperatures and reduced throughputs; however, the increased gas production lowers the gasoline recovery at higher temperatures; and as, at the present time, Pemex can meet the specifications of its products with straight run gasoline, this type of operation is not required.

Regeneration of the catalyst is accomplished by burning the carbon off with a mixture of air and superheated steam under controlled conditions. Thermocouples placed in the catalyst bed allow the progress of the burning to be closely followed and regulated. The catalyst in a chamber on this unit can be regenerated in less than 24 hours after processing straight run gasoline for more than two weeks at desulfurization temperatures. When charging a mixture of cracked and straight run, or when operating at reforming temperatures, the processing period is decreased. Still, the processing period on a given chamber is much longer than the time required for regeneration and permits a simple and unhurried regeneration operation.

The bauxite catalyst used is very rugged and in this particular unit has been in service since July 1952. There is no sign of reduced activity to date. (In the Salamanca refinery of Pemex, the catalyst has been in service for more than two and one-half years and continues to give good results.)

Addition of the Cycloversion unit to the Mexico City refinery has reduced its consumption of TEL by more than a tank car per month. The production of premium gasoline (Super-Mexolina), 80 octane motor method, has been considerably increased and it is no longer necessary to use aviation grade alkylate in blending this product. Blending of the regular grade gasoline (Mexolina) has been simplified and a worthwhile lead saving effected. The management of Pemex is well satisfied with the results obtained from the unit and is planning to expand the desulfurization capacity of the refinery in the near future in order to keep pace with other plans to increase the pipe line and refinery crude capacity to approximately 80,000 bbl per day. * * *

TABLE 2. Inspection of Atzcapotzalco Perco unit samples.

Yield summary	Debutanized* charge	Debutanized† product
Yield, vol % as rec'd. stock	82.5	81.5
Yield, wt % as rec'd. stock	84.8	84.4
Inspection test results		
ASTM distillation, F		
First drop	111	105
5% evaporated	130	122
10%	142	137
30%	178	184
50%	222	228
70%	266	271
90%	315	318
95%	333	335
End point	359	359
Rec. vol, %	98.5	98.5
Res. vol, %	0.8	0.9
API, gravity at 60 F	66.5	65.7
RVP, psig at 100 F	6.1	5.4
Lamp sulfur, wt, %	0.079	0.012
Mercaptan sulfur, wt, %	0.028	0.007
Hydrogen sulfide, wt, %	0.003	Trace
Doctor	Sour	Sour
Bromine number	1.3	1.4
UOP K factor	12.29	12.27
ASTM octane number		
0 cc TEL/gal	43.2	47.6
1 cc TEL/gal	53.6	62.0
3 cc TEL/gal	64.0	72.4
Research octane number		
0 cc TEL/gal	40.7	46.7
1 cc TEL/gal	51.0	60.2
3 cc TEL/gal	62.3	72.5

* Analysis of debutanized charge showed 1.1 weight per cent (1.4 volume per cent) C_4's.

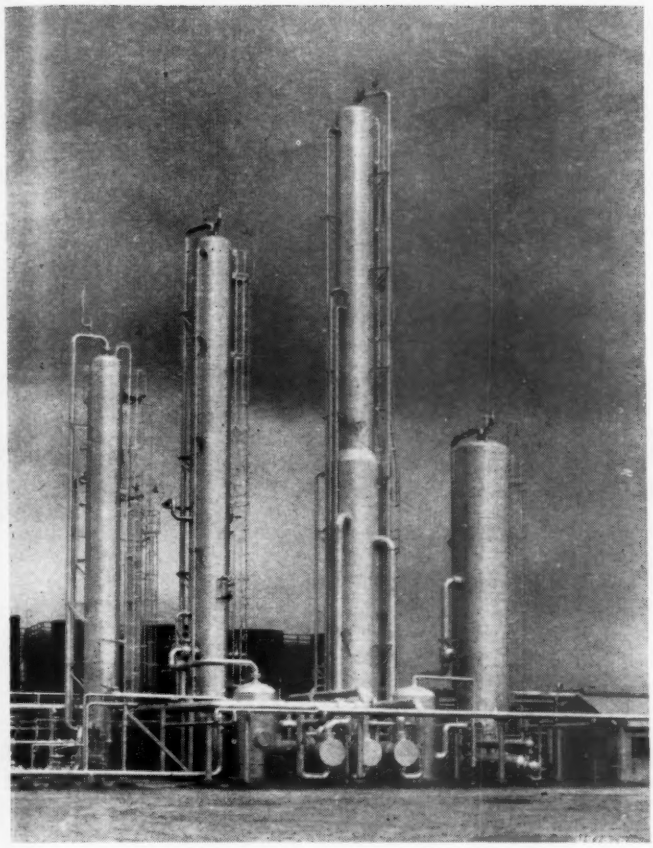
† Analysis of debutanized product showed 0.6 weight per cent (0.7 volume per cent) C_4's.

New Extraction Process Announced by Standard

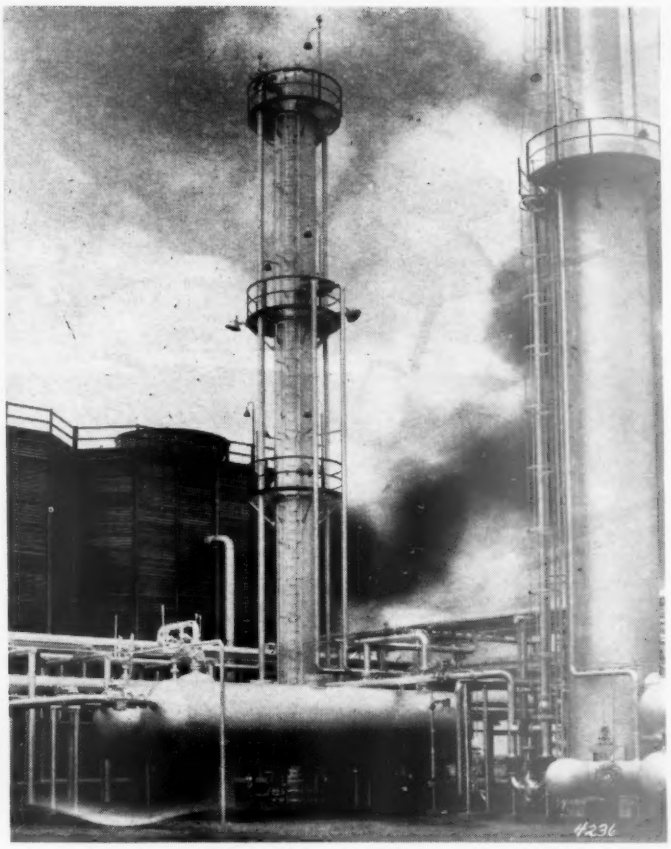
The NRC Mi-and-Settle Extractor Process of Standard Oil Development Company, is to be licensed solely by National Research Corporation, it is announced. This process was developed for Standard by Dr. M. R. Fenske, professor at Penn State College, Pennsylvania, and is a liquid-to-liquid contact process of unique design.

Flow of the liquids employed is countercurrent throughout the column, but in each stage it is co-current during each mixing and settling cycle. It is stated that equilibrium can be attained in each stage, also samples of each component may be drawn at each stage. Special castings are assembled, one atop the other in the column, and as many as 30 stages may be included in one unit. Each stage is only two inches in height.

The standard unit is suitable for research and for development work as well as for commercial, plant-scale operations. Additional information is obtainable from Equipment Division, National Research Corporation, 70 Memorial Drive, Cambridge 42, Massachusetts.



VESSELS AND TOWERS in gasoline plant of Texas Natural Gasoline Corporation near Rankin, Texas. Tallest tower is 109 ft, a "fat oil" stabilizer; next highest is a 6-ft by 82-ft. absorber.



A 4½-FT BY 79¼-FT absorber in Maysville, Oklahoma, plant of Warren Petroleum Company.

A Cost Comparison

Alternate Types of Vessel Construction†

Studies of comparative design data, as applied to plate construction of several steels, shed light on first costs

I. E. BOBERG and W. R. FICKETT*

Abstract

A first-cost investment in graphitization-resistant construction at some additional expense might, within limits, be considered as insurance. This paper evaluates first cost, as it applies to plate construction, of ASTM A 285, A 201, and graphitization-resistant A 301 steel at operating temperatures of 900 F, 950 F, and 1000 F. Consideration is given to designs where internal insulation is employed — permitting design temperatures of not more than 650 F, as well as designs utilizing external insulation only and employing unit stresses prescribed for these elevated temperatures by API-ASME Code for the Design, Construction, Inspection, and Repair of Unfired Pressure Vessels for Petroleum Liquids and Gases.

Stated assumptions have been made relating to the cost of insulations, stress relief, and radiographing. It should be pointed out that these vary, and have a marked effect on a cost comparison of this nature.

Introduction

IT is the purpose of this paper to deal briefly with some of the economic aspects of pressure-vessel design as influenced by a consideration of graphitization at elevated temperatures.

The occurrence of serious graphitization is not always predictable in advance. In many operations the financial loss which results from an enforced shutdown is so tremendous that a relatively unpredictable risk cannot be justified. As one operator remarked after the failure of an important vessel: "We could afford to build every such vessel of solid stainless, if by so doing we could avoid one shutdown."

That remark was figurative rather than literal, but it serves to focus attention on the trend toward the consideration of graphitization-resistant construc-

†Presented at 18th mid-year meeting of the American Petroleum Institute's Division of Refining, Commodore Hotel, New York, N. Y., May 11, 1953.

*Chicago Bridge and Iron Company, Chicago, Illinois.

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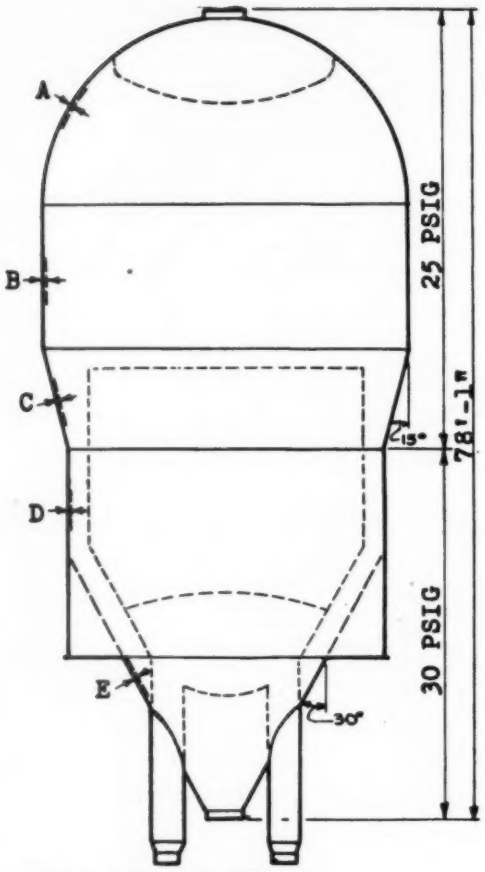

FIG 1. TYPICAL DESIGN data on a field -built reactor vessel as used in calculations shown in Table 1.

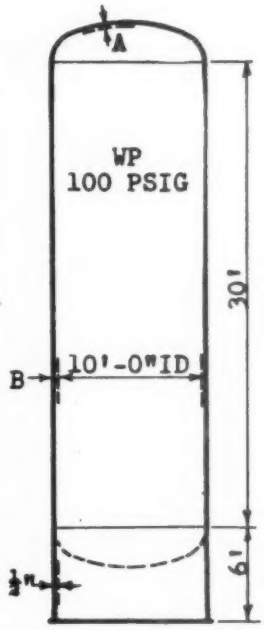

FIG. 2. TYPICAL DESIGN data for a cylindrical vessel as constructed in shop, data used in Table 2.

tion even at some increase in first cost. Within limits, an increase might be considered as insurance.

In order to shed some light on the subject of first cost, it was suggested that it would be helpful to develop comparative information on several available alternatives. The alternative types of construction were selected by the committee in charge of this program, and the sole purpose of this paper is to evaluate them. Discussion of the merits of one alternative over another is left for the papers of a more technical nature.

Vessel Selection and Evaluation

Two vessels were selected for comparison, viz., one to be field-erected and one to be shop-built. In order to obtain the picture over a range of temperatures, it was suggested that all comparisons be made at 3 temperatures, as follows: 900 F, 950 F, and 1000 F.

Each vessel has also been evaluated for three types of construction, as follows:

1. Mild steel, with internal insulation, to reduce the steel temperature to not more than 650 F. The diameter of the vessels under this alternate has been increased 10 in. in order to provide the same net capacity inside the insulated surfaces.

2. Mild steel, without internal insulation, utilized at the unit stresses permissible under the *API-ASME Code for Unfired Pressure Vessels for Petroleum Liquids and Gases* for the specified metal temperatures of 900 F, 950 F, and 1000 F.

3. A graphitization-resistant steel (ASTM A 301, grade "B") without internal insulation, utilized at the unit stresses permissible at metal temperatures of 900 F, 950 F, and 1000 F. This steel contains 1 per cent chromium and ½ per cent molybdenum.

In the selection of the mild steels for alternates (1) and (2), the lowest-cost material has been used in each case. The API-ASME code permits the use of ASTM A 285, grade "C," at steel temperatures up to and including 900 F. Therefore, ASTM A 285 C has been used for the 650 F temperature and also for the 900 F.

For the 950 F and 1000 F steel temperatures, A 201 or A 212, in either grade "A" or "B," could be used. The base cost of both steels is the same; but, inasmuch as there is no difference in allowable unit stresses at the temperatures being considered, ASTM A 201 B has been selected because of its better weldability.

All steels used are of firebox quality.

The field-erected vessel chosen for comparison is an actual reactor soon to be constructed. Its shape and dimensions are shown in Fig. 1. As it is to be built, the shell and the upper 12 in. of the supporting skirt are of ASTM A 301 B (1 per cent chromium; ½ per cent molybdenum; maximum carbon content, 0.12 per cent). The balance of the skirt is of ASTM A 285 C. The internals furnished by the fabricator include the inner cone and shell, grid, and stripper cells. The cyclones and hanger rods were not included in the fabrication contract and, hence, are not included in the estimates that follow.

For the shop-built vessel, the simple structure shown in Fig. 2 was chosen. A small amount of internals was included. A pressure of 100 psi was considered reasonably representative of a probable range from 40 psi to 180 psi.

Clarification of Factors

Before the relative costs of all the alternates described hereinbefore are discussed, certain limitations and controversial factors should be clarified.

1. It should be realized that the comparisons apply only to the particular vessels under consideration. Although it is believed that the examples selected are reasonably typical, it would be dangerous to extrapolate the results to other vessels which have materially thicker or thinner shells. Stress-relieving and X-ray requirements vary with shell thickness, and could materially change the picture in other thickness ranges. Insulation quantities would also vary widely with shape.

2. It should be realized that ASTM A 301 B is a relatively new material with which there has been very little experience in field-erected plate work. The estimates contained herein are believed to be reasonably accurate; nevertheless, it is true that, as more experience is gained, the fabricators will learn more about whether they are underestimating or overestimating the difficulties of handling this material.

3. It should be made clear that, at the present time, there appears to be considerable controversy and wide difference of opinion on the subject of insulation of vessels in this category. For instance, it appears that the general belief is that, where an internal liner is employed in a vessel for heat-insulating purposes, the external surface of the vessel should be left bare so that any hot spots indicating failure of the internal liner may be detected immediately. Others believe that external insulation is necessary. There is also divergence of opinion concerning the amount and type of insulation. From the standpoint of adequacy for field stress-relieving, some of the fabricators will undoubtedly disagree with the amount and quality of temporary insulation often provided in those cases where permanent exterior insulation is not included.

Insulation Specifications

Except for the temporary covering necessary for field stress relief, this entire matter of insulation is beyond the range of the authors' experience. We are not prepared to discuss the relative merits of the various practices, and have necessarily turned to the committee in charge of this program to specify definitely the type and amount of insulation to be included in each case.

As a result, it was concluded that the vessels operating at steel temperatures

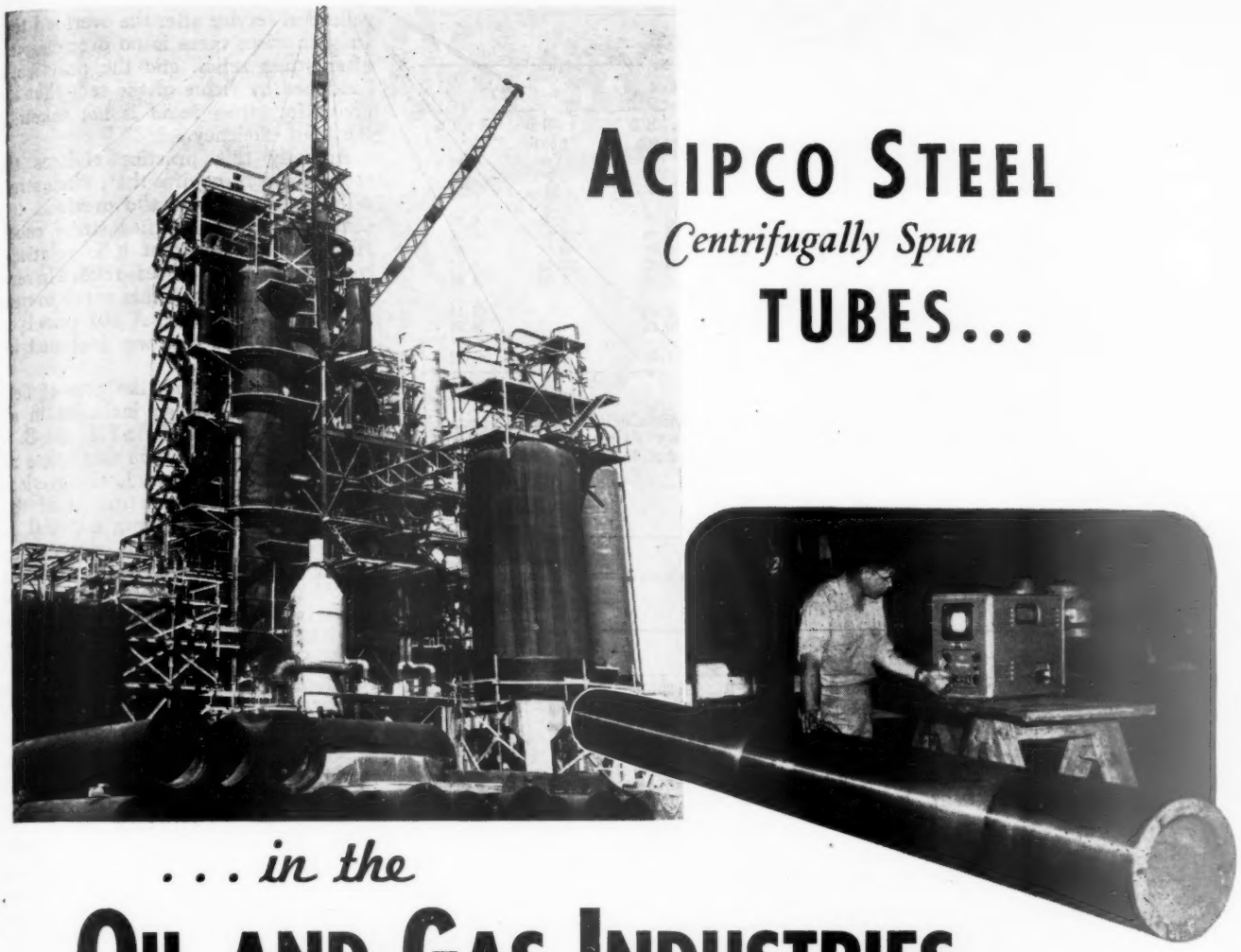

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TABLE 1. Field-erected reactor.

Steel temperature (Fahrenheit):	650	900		950		1000	
Material (ASTM):	A 285 C	A 285 C	A 301 B	A 201 B	A 301 B	A 201 B	A 301 B
Unit stress, psi	13,750	6,500	13,100	4,500	11,000	2,500	7,500
X-ray	No	Yes	Yes	Yes	Yes	Yes	Yes
Stress-relieve	No	No	Yes	‡	Yes	‡	Yes
Joint "E" per cent	80	90	95	90	95	90	95
Thickness, inches:							
A	0.64	1.00	0.58	1.00	0.65	1.35	0.90
B	0.64	1.06	0.58	1.47	0.65	2.56	0.90
C	0.66	1.09	0.59	1.52	0.67	2.64	0.92
D	0.66	1.09	0.59	1.50	0.67	2.62	0.92
E	0.73	1.23	0.65	1.72	0.75	3.00	1.03
Cost, dollars:							
Vessel	0.70	0.97	0.92	1.12	0.95	....	1.12
Insulation	†0.30	*0.15	*0.15	*0.15	*0.15	....	*0.15
Total	1.00	1.12	1.07	1.27	1.10	....	1.27

Note: All thicknesses include 1/16-in corrosion allowance.
* 4-in. insulation outside only. Cost basis, $4 per square foot.
† 4-in. insulation inside only. Cost basis, $8 per square foot. Vessel size increased to yield same inside capacity. For extremes of insulation, i.e., cost range from $3.50 to $9.50 per square foot, the 650-F vessel costs would be as follows:

	$3.50 per square foot	$9.50 per square foot
Vessel	0.70	0.70
Insulation	0.13	0.36
Total	0.83	1.06

‡ Stress-relieve in service.

TABLE 2. Shop-built vessel.

Steel temperature (Fahrenheit):	650	900		950		1000	
Material (ASTM):	A 285 C	A 285 C	A 301 B	A 201 B	A 301 B	A 201 B	A 301 B
Unit stress, psi	13,750	6,500	13,100	4,500	11,000	2,500	7,500
X-ray	No	No	No	Yes	No	Yes	No
Stress-relieve	No	No	Yes	Yes	Yes	Yes	Yes
Joint "E," per cent	80	80	85	95	85	95	85
Thickness, inches:							
A	0.50	0.94	0.44	1.38	0.56	2.49	0.81
B	0.60	1.17	0.55	1.43	0.65	2.59	0.95
Cost, dollars:							
Vessel	0.54	0.63	0.66	0.85	0.70	1.47	0.83
Insulation	†0.46	*0.23	*0.23	*0.23	*0.23	*0.23	*0.23
Total	1.00	0.86	0.89	1.08	0.93	1.70	1.06

* 4-in. insulation outside only. Cost basis, $4 per square foot.
† 4-in. insulation inside only. Cost basis, $8 per square foot. Vessel size increased to yield same inside capacity. For extremes of insulation, i.e., cost range from $3.50 to $9.50 per square foot, the 650-F vessel costs would be as follows:

	$3.50 per square foot	$9.50 per square foot
Vessel	0.54	0.54
Insulation	0.20	0.55
Total	0.74	1.09

of 900 F, 950 F, and 1000 F should be provided with 4 in. of external insulation. This insulation consists of 2 in. of magnesia and 2 in. of asbestos which has been included at an estimated cost of $4 per square foot, including the cost of weather-proofing.

The internally lined vessel, which operates at a temperature of 650 F, is to have no external insulation.

Opinion varied widely on internal insulation, depending on whether a simple type was employed or a castable type retained by a dense castable surface layer with reinforcing mesh supported from the shell. There was considerable opinion in favor of the latter type, at an estimated cost of about $8.00 per square foot. The committee decided, however, that we should also indicate the probable maximum and minimum values of $3.50 and $9.50 per square foot.

While on the subject of insulation, there is one comment which seems appropriate, even though not one of the examples chosen is affected by it. Where field stress relief is necessary, and where no permanent exterior insulation is included, temporary insulation is required. It is axiomatic that any temporary expedient should be accomplished as cheaply as possible, but there is a tendency to defeat the intended purpose by skimping too much on insulation. Our experience indicates that the 2-in. rockwool blanket, which is often used, is completely inadequate for stress-relieving at 1100 F to 1200 F unless the vessel is exceptionally well sheltered from the wind.

Field-Erected Vessels

With that preliminary explanation, the data for the various alternatives for the field-erected vessel are shown in Table 1. Some comment appears desirable. Essentially the designs are in accordance with the API-ASME code, but there are some deviations in an effort to conform with the prototype selected and with what appears to be common practice.

Perhaps the principal deviation is in the X-ray requirements. The API-ASME code would not require X-ray for ASTM A 301 B below a thickness of 1 in.; but it was the committee's feeling that, until more experience with this material has been gained, field-erected structures should be X-rayed in all thicknesses.

A word of explanation concerning stress relief will also be helpful. When a vessel is to operate at a metal temperature of not less than 900 F, there is a tendency of many owners to stress-relieve in service after the overload test. In such cases there is no overload test after stress relief, and the practice is condoned by virtue of the fact that the credit for stress relief is not taken in the joint efficiency.

Actually this practice violates the code — which requires that, when stress relief is mandatory, the overload test shall be performed after stress relief. However, the fact that it is relatively common practice to stress-relieve in service led the authors of this paper to treat the ASTM A 285 and A 201 vessels in this manner. No cost was included for field stress relief.

On the other hand, the cost of field stress relief has been included in all vessels constructed of ASTM 301 B. It is our considered opinion that stress relief should always precede the overload test on any vessel constructed of this or any other air-hardening material. In such cases it is not just a matter of relieving residual stress, but it is also a matter of heat-treating the weld metal and fusion zone so as to attain adequate ductility. In many cases there may be insufficient ductility in the "as welded" condition to permit the overload test to be passed safely. We urge caution in the continuation of the practice of stress-relieving in service when air-hardening steels are dealt with.

Cost Considerations

Cost information shown herein is relative. The cost of the internally insulated vessel which operates at a metal temperature not in excess of 650 F has been assigned a value of $1. The estimate for the ASTM A 201 vessel at 1,000 F has been omitted. Its shell thickness of 3 in. places it outside practical consideration for field erection. At any rate it can be said that lack of experience in this range would render any cost estimate unreliable.

It will be observed that, in every case, the internally insulated vessel of mild steel represents the lowest cost for the field-erected reactor. The degree of cost advantage depends on the cost attributed to insulation. For those who believe that external insulation is also necessary, the cost advantage may disappear.

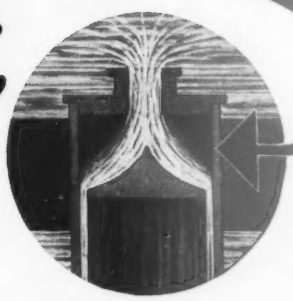
It should also be pointed out that the lower first cost of the internally insulated vessel may not necessarily recommend it as the best solution. The authors have already professed inability to discourse on the merits of the various alternatives, but there are certain factors which should be mentioned for the benefit of those who might read this paper and who might be unaware of the planned discussion which is to follow. There is the matter of erosion; there is also the problem of loss in efficiency which results from the deposition of carbon on the inside surface; and, furthermore, there is the possibility of corrosion which is caused by condensation against the cooler shell. Useful life and possible maintenance of insulation may also be factors.

Without any attempt at evaluation of these and other factors, it is sufficient to

XUM

Dirty Water can't "Shut-down..."

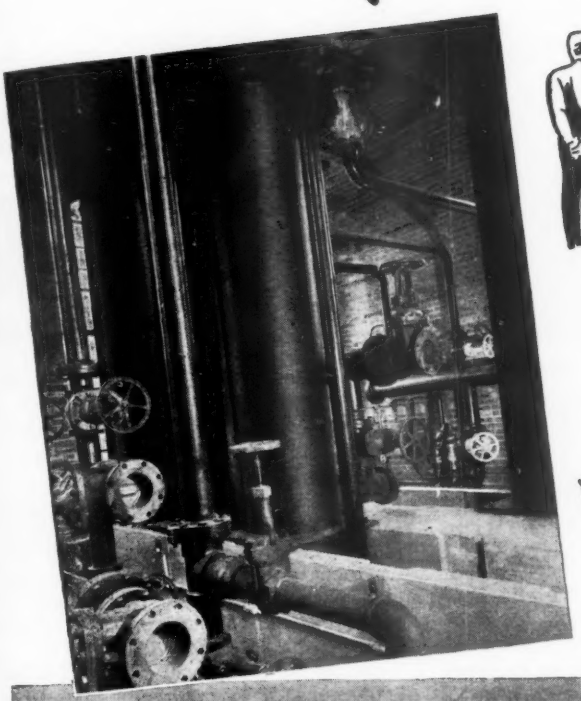
Vogt

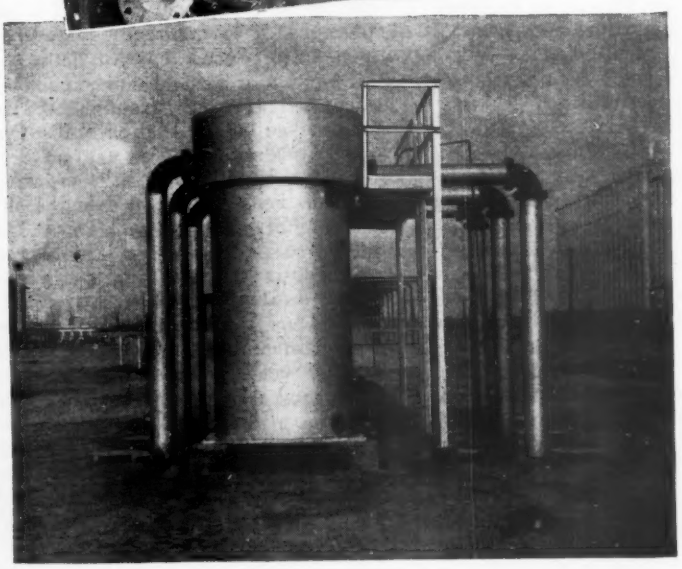


film type exchangers

(Condensers—Coolers—Evaporators)

Patent Nos. 1,935,270 - 2,057,597 - 2,424,441





River water, well water or brackish water are all alike to this exchanger *because it can be cleaned* while in operation! The water distributing ferrules need only be removed successively for the cleaning brush or tool whereby the tubes receive additional water which sluices away the dislodged dirt.

Vogt Film Type Exchangers are operating with real economy of first cost, operation and maintenance in power, petroleum, and chemical industries. They serve as Jacket Water Coolers, Feed Water Heaters, Hydrocarbon Evaporators, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to cool or heat any liquid and to condense or evaporate any fluid.

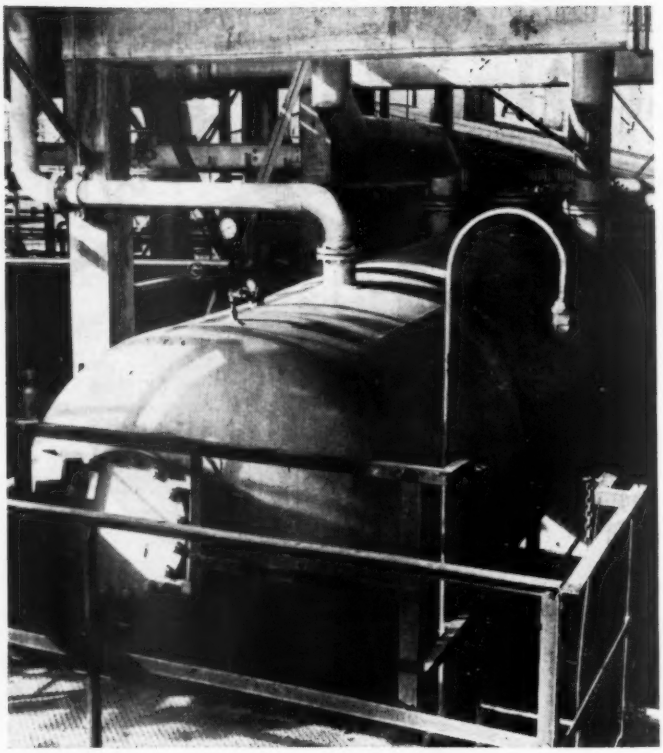
TOP: *Four units at Newton Falls, Ohio Municipal plant cool water for diesel engines and a lubricating oil cooler.*

BOTTOM: *Jacket Water Coolers serving engines of 7,300 HP in the compression plant of a Western Oil Refinery.*

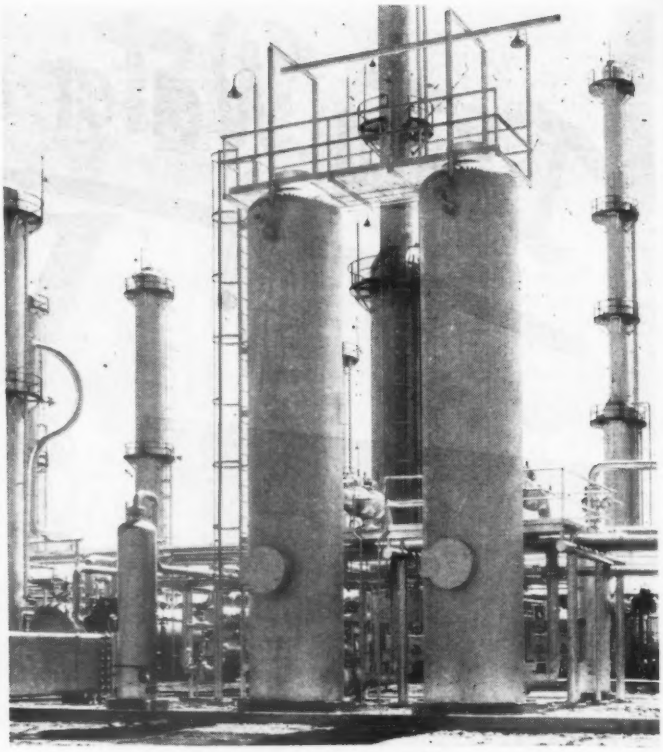
[Bulletin HE-7 describes typical installations of Vogt Film Type exchangers and is available upon request.]

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.



REFLUX DRUM in Baton Rouge refinery of Esso Standard Oil Company, 7½-ft diameter.



DRUMS AND TOWERS at Maysville, Oklahoma, gasoline plant. Two foreground structures are dehydrator chambers, stress-relieved and X-rayed, designed for 800 psig working pressure.

point out that the proper choice may involve more than first cost. Discussions that follow this paper will serve to enlarge on factors other than cost.

Shop-built Vessels

Table 2 shows similar information for the shop-built vessel. In this case we have adhered strictly to the API-ASME code in all respects. In view of the foregoing discussion, it would appear that no further discussion is essential to the interpretation of the data shown.

Welding Problems

It was suggested that mention be made of the problems inherent in the welding of 1 per cent chromium—½ per cent molybdenum steel. Unfortunately there is no extensive experience background in the construction of vessels with this type of steel. There has been experience with such materials as pipe. At this writing, extensive tests of various electrodes are planned, but these tests have not been completed. By the time of the mid-year refining meeting the tests should have been completed, and additional information may be available.

There has been some experience with ASTM A 301, grade "A," which is ½ per cent chromium and ½ per cent molybdenum. So far as we know, at least four field-erected vessels of this material have been constructed by ourselves and others. Based on piping experience, i.e., to the effect that no serious graphitization had ever been experienced in weld metal, all of these vessels were welded with carbon-molybdenum electrode, probably an ASTM A 316 48-T, classification E 7010. No serious constructional difficulties were encountered.

During the course of this meeting you will hear reports from the Battelle Memorial Institute which indicate that graphitization has been found in weld metal, and that the chromium content of the weld metal and fusion zone may be important. We mention this — perhaps prematurely — only for the reason that, if this can be established as fact, the successful field welding of ASTM A 301, grade "A," with carbon-molybdenum electrode may have very little significance in any assessment of future work. Before future work of this class is made unnecessarily complicated, it is to be hoped that all evidence will be scrutinized carefully, and that the degree of hazard will be properly evaluated.

With regard to the one vessel which has thus far been constructed of ASTM A 301, grade "B," the reports which reach us indicate that a very considerable amount of trouble from weld porosity and cracking was encountered in the shop where a large part of the welding was done. The cracking occurred principally in the vicinity of fittings. Strangely enough, the closing welds in the field gave very little trouble.

It is possible that the porosity might be attributable to the use of an ASTM 9016 (low-hydrogen) electrode. It is our intention at least to experiment with what might be termed an 8010 electrode, in which about 1 per cent chromium is included in the coating. The test will consist in whether the chromium content of the weld metal and fusion zone can be maintained at satisfactory levels by this method. If it cannot, it may be necessary to use low-hydrogen electrodes, and to attempt elimination of porosity by means of procedure and by careful attention to keeping the electrode dry.

In view of the present dearth of actual experience, it is impossible to outline any definite procedures. No doubt we shall know a great deal more about the subject several months from now. In the meantime we believe that carefully controlled preheating can do a great deal toward the elimination of the cracking which has been experienced in the air-hardening of materials such as ASTM A 301 B, especially around highly restrained fittings. Preheating over a sufficient area should slow down the cooling rate and permit entrapped hydrogen to escape. With preheat it may well prove unnecessary to risk porosity troubles through the use of low-hydrogen electrodes.

Based on limited experience with ½ per cent chromium and ½ per cent molybdenum steel, it is our present opinion that a preheat temperature of 300 F should be adequate.

The carbon content of the steel is important to determining the procedures which are necessary. One producer stated that it was necessary to keep carbon below 0.17 per cent if cracking was to be avoided during rolling. It would seem prudent to order ASTM A 301 B with a maximum carbon content of 0.15 per cent, or even less, if this is obtainable. In our own work, we would always order this material to be normalized at the mill. ★ ★ ★

FIG. 1. Soil pressure diagram for firewall bases.

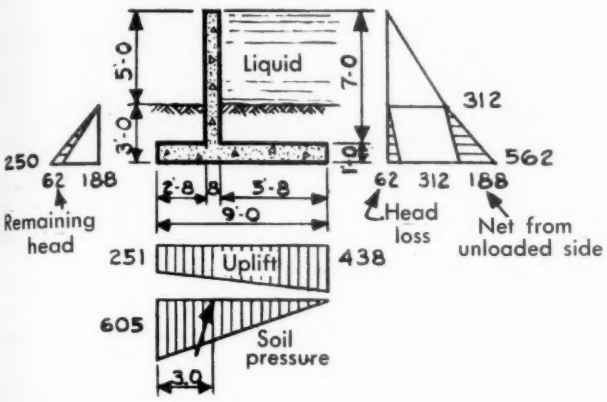


FIG. 2. Firewall base dimensions for Case I.

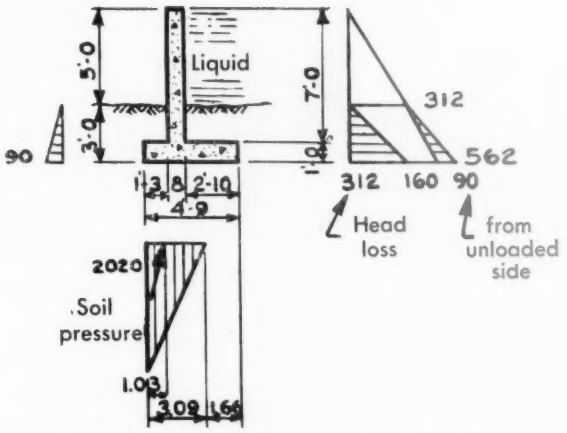


FIG. 3. Firewall base dimensions for Case 2.

The Design of Bases of Concrete Firewalls

Definitely practical assumptions must be made for various factors in designing firewalls

EDWARD WOLFSON

PROPORTIONS of concrete firewalls around tanks have long been a subject of disagreement in refinery engineering. On one hand there is the group who considers that since the walls may never be called on to retain liquid, the bases should be of only nominal size. On the other are the structural designers who insist that since the walls are installed to care for a head of liquid, if a tank should ever rupture, that the conditions of liquid pressure should be used in the design.

Liquid pressure on a retaining wall is more severe than earth pressure. In fact, in order to assure that there will be no tension on the base, that is, that the resultant will not be outside the middle third, the width of the base will usually be greater than the total height. The Ohio River flood walls at Huntington and Parkersburg, West Virginia, that have a total height of 24 to 29 ft, have base widths of 25 to 30 ft.

Knowing that such proportions of base width to height are considered excessive by others, Sohio's structural engineers have adopted for firewalls a set of assumptions which not only reduce the base to a considerably smaller dimension, but do so by the use of principles which designers are willing to accept. Although these assumptions are liberal, it must be remembered that they are used only for an emergency condition. This situation may be considered analogous to the specification of the American Institute of Steel Construction that permits a 33⅓ per cent increase in stresses when wind is used in combination with other forces.

Special Assumptions

These assumptions are stated as follows:

1. In the usual liquid-retaining wall, the liquid is assumed to lose head uniformly as it creeps from the ground surface on the loaded side, under the base and up to the ground surface on the unloaded side. For a firewall, Sohio has assumed that the total head is lost at the bottom of the base on the loaded side. Thus all the effect of uplift is eliminated.

2. Ordinary walls are designed with the resultant within the middle third, i.e., the entire base is in compression. Sohio permits tension on about 1/3 of the base of firewalls. The soil pressure diagram for this condition is shown in Fig. 1(c). Fig. 1(a) shows the shape of the pressure diagram when the resultant is inside the middle third and Fig. 1(b) when it is exactly at the third point.

Such assumptions reduce the base width to about 60 per cent of the total height.

Example

The following example illustrates the difference in method and result between a design using classical principles and one using the Sohio assumptions. Water is the liquid used by Sohio for all fire-

EXCLUSIVE

The Author

Edward Wolfson is a specialist on pressure vessels and civil engineering work for Standard Oil Company of Ohio, after being in charge of the civil engineering squad in Sohio's design group from 1944 to 1952. Prior to 1944, after graduating with a Bachelor of Science in civil engineering from Ohio State in 1937, he worked with the Cuyahoga County (Cleveland) Bridge Department up to December, 1939 and then went with the U. S. Engineers at Huntington, West Virginia, where he was engaged in designing Ohio River flood walls and other various flood control structures.

Following that, for two yers, 1941-43, he was employed by Arthur G. McKee Company, Cleveland, as a designer-draftsman on steel mill construction, after which he worked with Fisher Body Company, as a structures engineer in designing parts for B-29 bombers.

wall designs since the heaviest liquid which may be stored in a tank, heavy fuel oil, has a specific gravity of almost 1.

Data

(Different values may be preferred by others)

Concrete ..... 150 lb per cu ft
Water ..... 62.5 lb per cu ft
Dry Earth ..... 100 lb per cu ft
Saturated earth ..... 120 lb per cu ft
Horizontal pressure of dry earth ... 30 lb per ft per ft of depth
Horizontal pressure of saturated earth = $4/3 \times 62.5$ ..... 83.3 lb per ft per ft of depth

For this example a liquid depth of 5 ft and a frost line depth of 3 ft are used. The stem is 8 in., the minimum practical thickness. The stem is centered at 1/3 the width from the toe, the economical position.

Case 1 — Usual Assumptions

Head reduces to zero at the ground surface on the unloaded side. Resultant must not be outside the third point.

From Fig. 2:

Pressure at ground line $= 5 \times 62.5 = 312$
Pressure at base $= 312 + 3 \times 83.3 = 562$
Length of creep $= 3 + 9 + 3 = 15$
Loss of head per foot $= \frac{312}{15} = 20.8$

Loss at base $= 3 \times 20.8 = 62$
Uplift at heel $= 8 \times 62.5 - 62 = 438$
Uplift at toe $= 438 - 9 \times 20.8 = 251$
Total active pressure at unloaded side $= 3 \times 83.3 = 250$

By taking moments about the toe, the soil pressure diagram shown was obtained with the resultant at 3 ft from the toe. Thus, it is seen that to fulfill the requirements of this design, the base must be wider than the total height.

Case 2 — Liberalized Assumptions

Head reduces to zero at the base on the loaded side. Tension permitted on approximately 1/3 of the base.

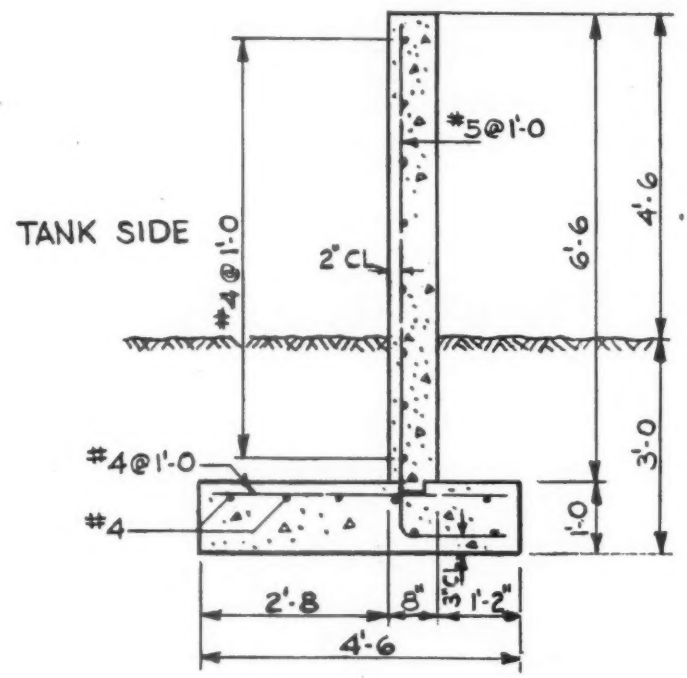
From Fig. 3:

Pressure at ground line and base as before.
Length of creep . . . . = 3
Total head loss at base . . = 312
Active pressure at unloaded side $= 3 \times 30 = 90$

By taking moments about the toe, the soil pressure diagram shown in Fig. 3 was obtained, with the resultant at 1.03 ft from the toe. There is tension on 1.66 feet, or 34.9 per cent of the base. Instead of a base width of 112.5 per cent of the total height, the width is now 59.4 per cent.

From this analysis it can be seen that a base width of about 60 per cent of the total height, with 1/3 on the toe side and 2/3 on the heel side, will be satisfactory for firewalls. ★ ★ ★

Typical firewall built around floating-roof tanks in a Sohio refinery.



Cross-section of a 4 ft 6 in. firewall designed by Sohio method.

Pulled after 4½ years in a sour well

—corrosion negligible

These Monel valves served 4½ years in a sour crude well. When they were pulled, they showed practically no corrosion.

Here's the story of seven veteran Monel® gas-lift valves.

These valves, made by GARRETT OIL TOOLS, INC., gave excellent service for 4½ years in a well producing sour crude.

Careful examination showed the valves to be in excellent condition. Years of exposure to highly corrosive well fluids had produced only negligible signs of attack.

With service records like these, it's no wonder that Monel has become the standard material for all GOT gas lift valves.

GOT made their first pressure charged gas lift valve in 1946. Some of them have been in continuous service as long as 6½ years.

The reason for this long service lies in the combination of the right material and correct design. In addition to all-Monel construction, for example, the seamless bellows — the very heart of the valve — is given extra protection against excess pressures, distortion and contamination. It is supported on the inside by a valve stem guide . . . and on the outside by a non-compressible liquid. This extra protection permits higher pre-charged dome pressures without damage to the bellows.

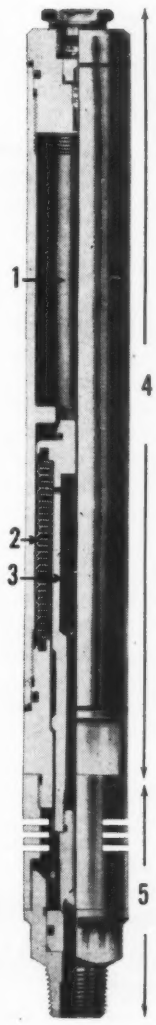
A pressure-charged dome replaces the pressure-charged bellows to hold the valve in closed position. The dome pressure can be changed in the field, permitting easy repair of valves as needed.

The fact that all types of GOT valves are interchangeable on one basic body reduces obsolescence and permits smaller inventories. Operators can thus easily convert their original valves to other types as well conditions change.

You can get detailed information on GOT valves by writing to Garrett Oil Tools, Inc., 2600 Nottingham St., Houston 5, Texas.

And remember, you can always call on Inco's Corrosion Engineering Section for help with your particular oil field corrosion problem.

It is advisable to place equipment orders with your supplier well in advance of scheduled use. Distributors of Inco Nickel Alloys can supply the latest information on availability from warehouse and mill.



1. Dome
2. Bellows
3. Valve Stem Guide
4. Type "O" Body
5. Type "O" Head Piece Assembly

Cutaway view of the Type "O" GOT Pressure Charged Gas Lift Valve. The body and the internal parts are made of corrosion-resisting Monel.

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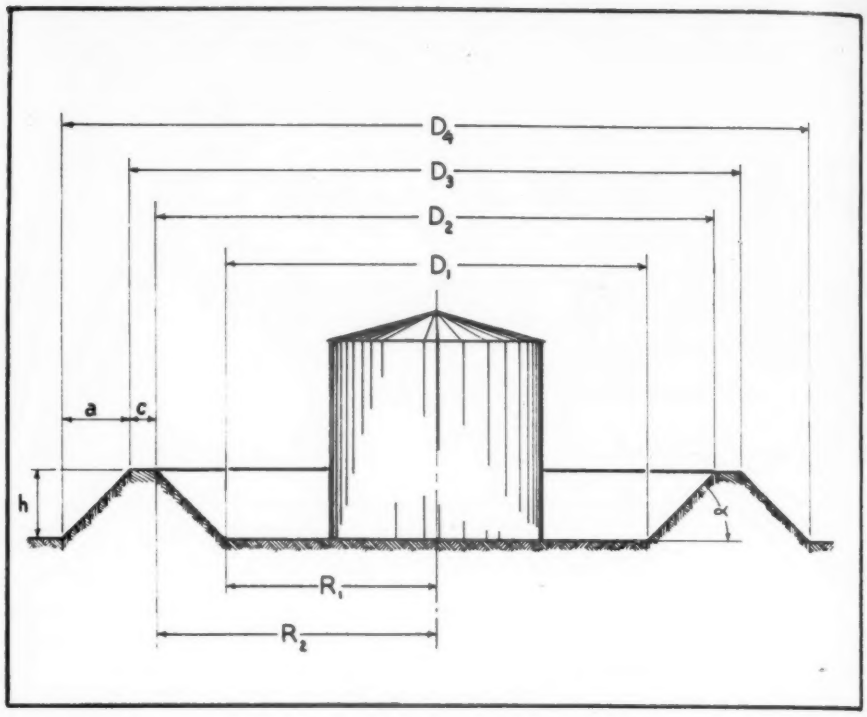


FIG. 1. Dimensions referred to in Figs. 2 and 3.

Graphs Save Time In Dike Design

JOSEPH R. WILSON

In development of earth dikes for tanks containing inflammables, the selection of optimum height and diameter often involves trial and error. In locations of limited area where the smallest outside diameter (D_4) is desired, the selection is even more lengthy. As the height is increased up to a point the outside diameter decreases. This height (maximum effective height) gives the minimum outside diameter (D_4) for a given volume. Further increases in height result in increasing this outside diameter.

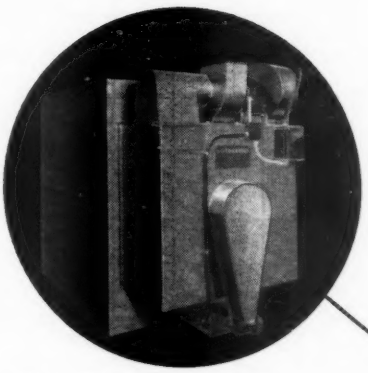
A quick and practical method of determining the diameter and height of any dike of a known volume is presented in the two graphs. Volume in barrels is plotted against inside top diameter (D_2) in feet at various dike heights. The circled numbers along the maximum effective height curve show the maximum effective dike height in feet for these volumes. Each graph is for one of the two most common dike wall slopes (1 to 1 and 2 to 1).

By entering the graph of the desired slope at the desired volume in barrels (using tank volume plus safety margin

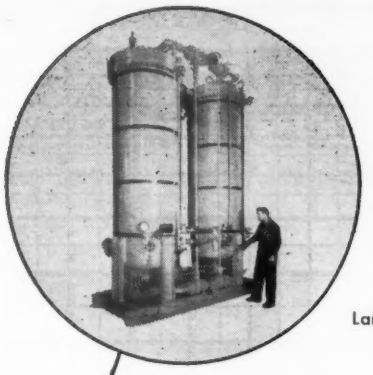
The Author

Joseph R. Wilson is a mechanical engineer on the staff of Stratford Engineering Corporation, where he works on innumerable problems involved in the development and design of Stratco refining and similar equipment. Before graduating from the University of Kansas in 1947 with a BS degree he had served in World War II as assistant engineer in destroyer service in the Pacific. Upon graduation he was on the design staff of Black and Veatch, consulting engineers, for four years and worked on design of several steam power plants. He spent a "hitch" as engineer officer on the frigate USS Everett on Korean duty, joining Stratford a year ago.

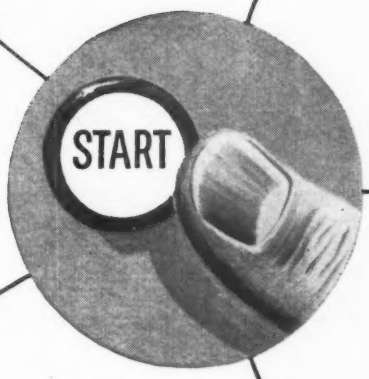
EXCLUSIVE

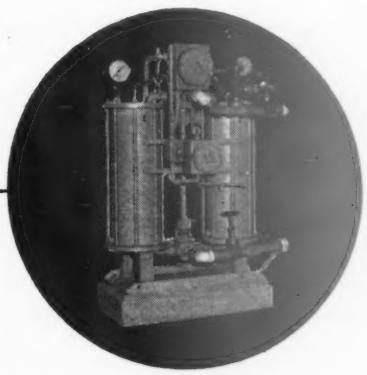


Air Conditioning Lectrodryer.

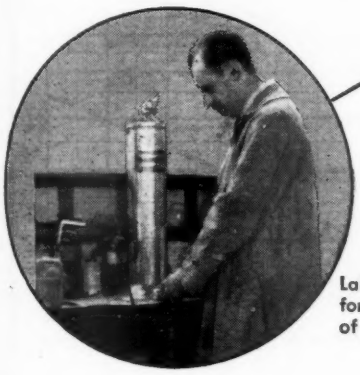


Large liquid hydrocarbon Lectrodryer.

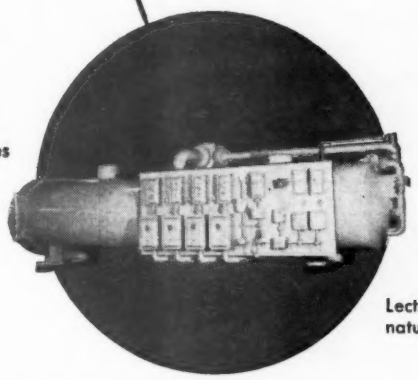




Small, dual compressed air dryer.



Laboratory Lectrodryer for drying small quantities of gases.



Lectrodryer for drying compressed natural gas.

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In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

*REGISTERED TRADEMARK U. S. PAT. OFF.

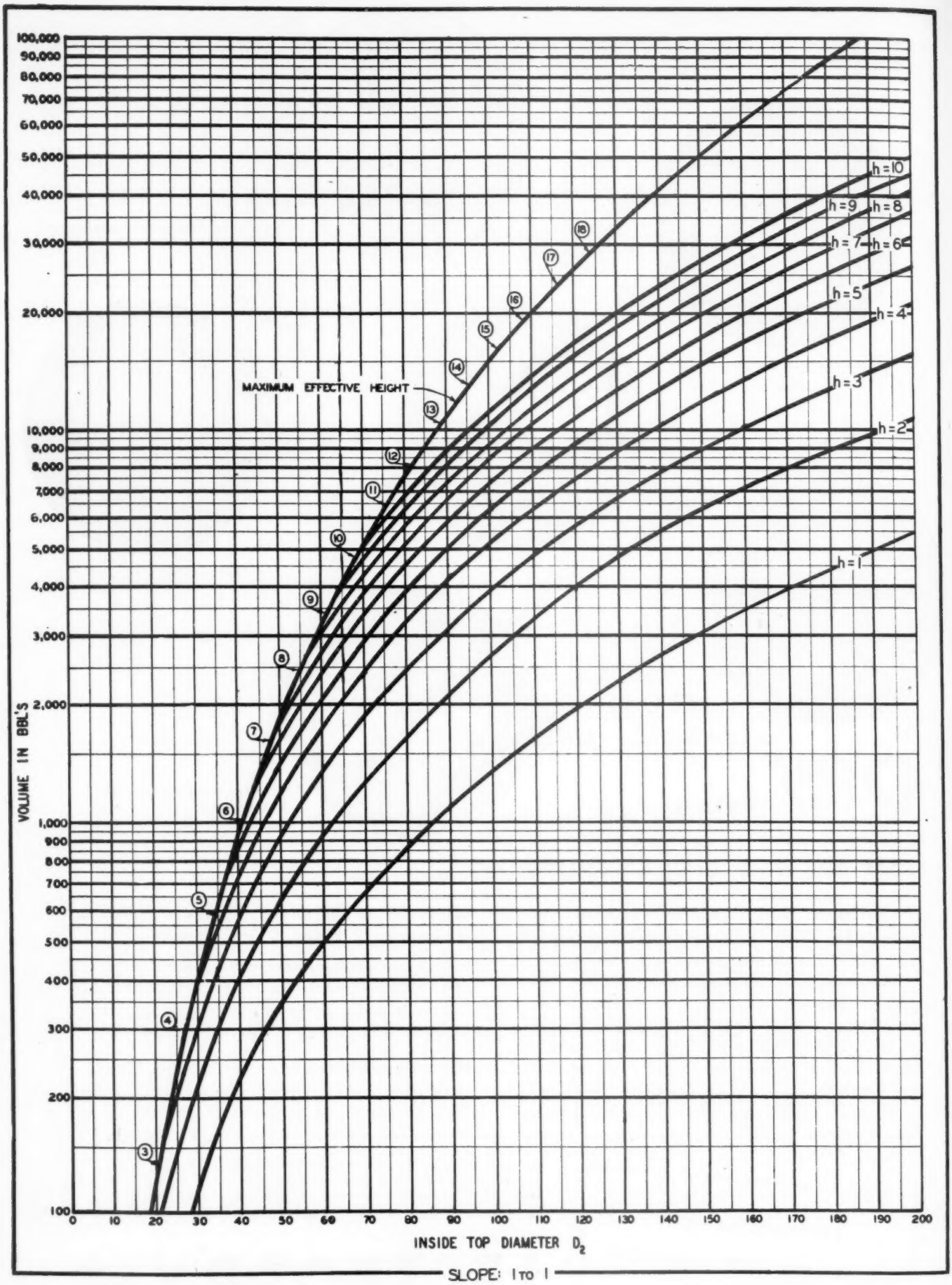


FIG. 2. Graphs for slope ratio of 1 to 1.

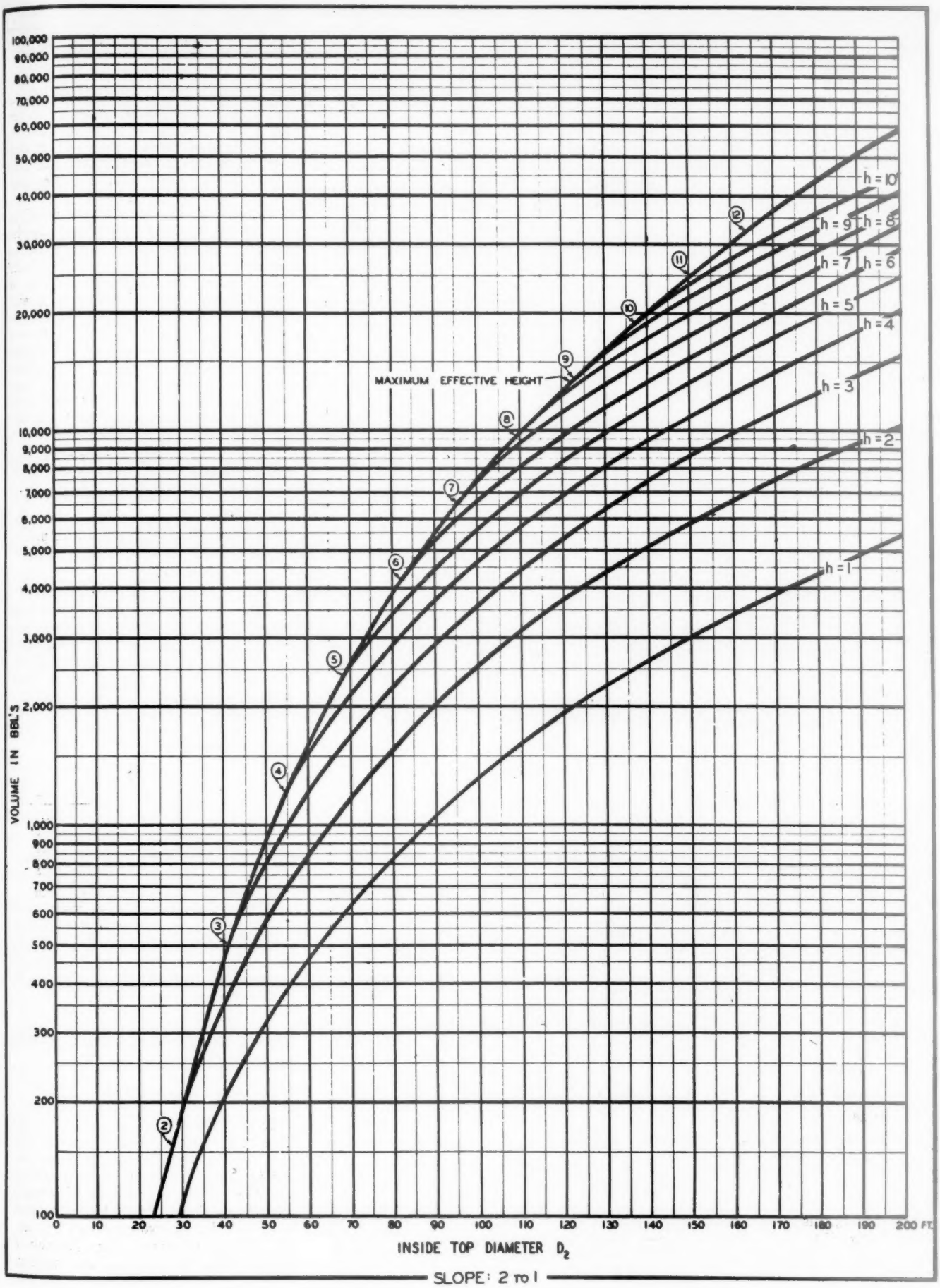


FIG. 3. Graphs for slope ratio of 2 to 1.

as actual dike volume); crossing to one of the family of height curves, the corresponding top inside diameter (D_2) for that height can be read. Other dike dimensions are easily obtained from the formulas below.

Slope of 1 to 1

$D_1 = D_2 - 2h$
$D_3 = D_2 + 2c$
$D_4 = D_2 + 2h + 2c$

Slope of 2 to 1

$D_1 = D_2 - 4h$
$D_3 = D_2 + 2c$
$D_4 = D_2 + 4h + 2c$

Example: To find the dimensions of a dike 4 ft high for a volume of 2000 bbl, 1 to 1 slope and 3 ft flat (c), enter the graph at 2000 bbl, and cross horizontally to the h = 4 line, reading the corresponding inside top diameter D_2 as 64 ft.

$D_1 = D_2 - 2h = 64 - 8 = 56$ ft.
$D_3 = D_2 + 2c = 64 + 6 = 70$ ft.
$D_4 = D_2 + 2h + 2c = 64 + 6 + 8 = 78$ ft.

Example: Find the dimensions at minimum outside diameter D_4 for a dike of 1000 bbl, at a slope of 2 to 1, and 2 ft flat top (c). Enter graph at 1000 bbl, and read D_2 at maximum effective height line, h = 3.7 ft, D_2 = 52 ft, then D_1 = 37.2 ft, D_3 = 56 ft, and D_4 = 70.8 ft.

To determine dimensions of dikes with minimum space requirements for slopes or sizes other than those plotted in the graphs, the following formula and its derivation is given:

$$\text{Volume} = 1.912R^3 \tan \propto$$

$$a = \frac{R}{1+\sqrt{2}}$$

$$h = a \tan \propto$$

(1) Volume of a frustrum of a right cone $\quad V = \frac{\pi h}{3}(R_1^2 + R_1R_2 + R_2^2)$

$$R_2 = R_1 + a$$

(1) $\quad V = \frac{\pi a}{3} \tan \propto (3R_1^2 + 3R_1a + a^2)$

(2) $\quad D_4 = 2(R_1 + 2a + c)$

Differentiating (2) $\quad \frac{dD_4}{da} = 2\frac{dR_1}{da} + 4 = 0$

(3) $\quad \frac{dR_1}{da} = -2$

Transposing (1) $\quad \frac{3V}{\pi \tan \propto} = 3R_1^2a + 3R_1a^2 + a^3$

(4) Differentiating $\quad 0 = 6R_1a\frac{dR_1}{da} + 3R_1^2 + 3a^2\frac{dR_1}{da} + 6R_1a + 3a^2$

Solving for $\frac{dR_1}{da}$ $\quad \frac{dR_1}{da} = -\frac{R_1^2 + 2R_1a + a^2}{2R_1a + a^2}$

(5) $\quad = -\frac{(R_1 + a)^2}{a(2R_1 + a)}$

Equating (3) and (5)

$$(R_1 + a)^2 = 2a(2R_1 + a)$$

$$0 = R_1^2 + 2R_1a + a^2 - 4R_1a - 2a^2$$

$$0 = R_1^2 - 2R_1a - a^2$$

Solving for R (quadratic) $\quad R_1 = \frac{2a \pm \sqrt{4a^2 + 4a^2}}{2}$

only real root $\quad R_1 = a + a\sqrt{2}$

$$a = \frac{R_1}{1+\sqrt{2}}$$

Substituting this root in eq. (1)

$$V = \frac{\pi R_1 \tan \propto}{3(1+\sqrt{2})}\left[3R_1^2 + \frac{3R_1^2}{(1+\sqrt{2})} + \frac{R_1^2}{(1+\sqrt{2})^2}\right]$$

$$V = \frac{\pi R_1^3 \tan \propto [3(1+\sqrt{2})^2 + 3(1+\sqrt{2}) + 1]}{3(1+\sqrt{2})(1+\sqrt{2})^2}$$

$$= 1.912R_1^3 \tan \propto$$

* * *

Plant Aids

How to Compute Collapsing Point of Thin Tubes, Pipes

Sometimes it is desired to compute the collapsing strength of tubes or pipes for various services in petroleum plants, handling dust, gases, etc. — tubes that are made of thin sheet metal and that are large in diameter. The writer suggests the following method:

Square the thickness of the metal in inches, mulitply by 1600, divide by the square of the diameter of the tube in inches, subtract the quotient from one (1) and then extract the square root of the difference. (This square root will always be less than one, of course. Thus if the difference is 0.64 the square root will be 0.8). Next subtract the square root from 1 and multiply the remainder by 500. The result of this is the collapsing pressure in pounds per square inch.

When written as a mathematical formula we have this: —

$$P = 500\left[1 - \sqrt{1 - \frac{1600\ t^2}{D^2}}\right]$$

Where

P = collapsing pressure in psi;
t = thickness of sheet metal, inches;
D = diameter of pipe, inches.

This is a modification of the well known "Stewart formula," which was developed for greater thicknesses and heavier metals such as used in boilers, flanged or screw piping, and large vacuum apparatus.

The above formula was arrived at by comparing the Stewart forumla with the following test results:

Diameter inches	Thickness inches	Noticeable distortion psi	Collapse psi
12	.0312	1.0	3.0
12	.0375	1.0	3.5
12	.05	2.5	7.5
15	.0375	1.5	3.0
15	.05	2.5	4.5
15	.062	3.0	7.5
15	.078	6.0 uncollapsed at	10.0

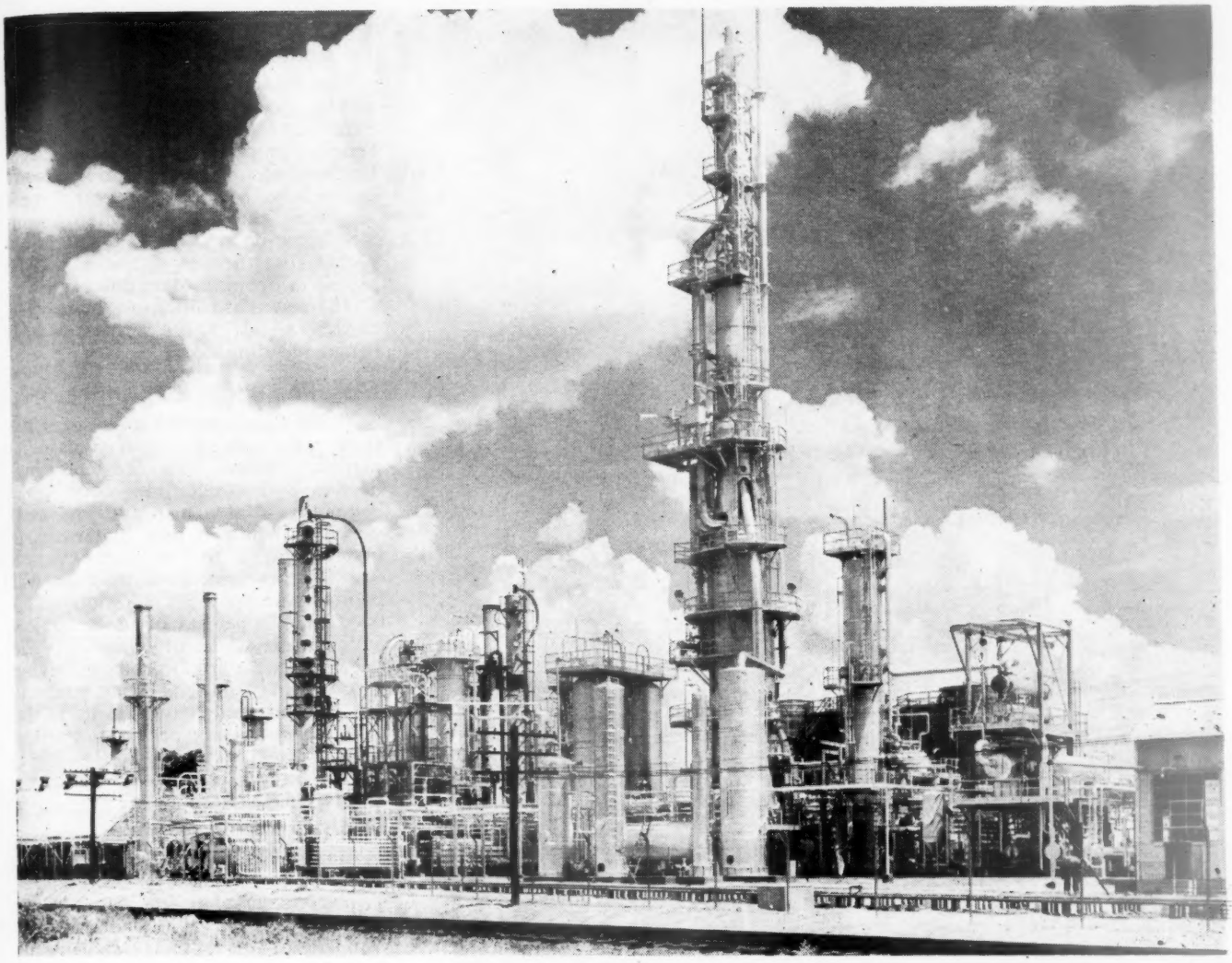
According to the ASME official publication "Mechanical Engineering," the above test results are credited to Walter S. Weeks, University of California, Berkeley, California.—W. F. S.

Colmonoy Thermocouple Wells In Hot Catalyst Lines*

M. B. OCKER

To withstand the very severe conditions in hot catalyst lines, thermocouple well sheaths of Colmonoy, a chromium boride alloy, are installed by sweating onto the surface of the 18-8 alloy wells already in place. Such 18-8 uncoated wells lasted only two weeks in one important installation; the Colmonoy coated wells have lasted six months, showing a considerable saving on one unit.

*This plant aid submitted through courtesy of the Humble Oil and Refining Company's Coin-Your-Ideas Plan.



NEWLY modernized refinery of Bay Petroleum Corporation in Denver has new fluid catalytic cracker in center.

Bay Petroleum to Build New Cat Cracking Unit

Bay Petroleum Corporation has completed a multi-million dollar expansion and modernization program at Denver, Colorado, and its new UOP fluid catalytic cracking unit is on stream. With extensive revamping of some existing facilities, Bay's Denver refinery is now one of the largest in the Rocky Mountain region.

The new cat cracker is designed for 3528 bbl per stream day of gas oil fresh feed at 76 per cent conversion, producing gasoline which has an octane rating above 91 without the addition of tethraethyl lead.

Universal Oil Products Company, Des Plaines, Illinois, designed, engineered and licensed the new cat cracker, an important landmark on the Denver skyline.

UOP engineers also redesigned and engineered the revamped facilities, which went on stream at the same time as the cat cracker. These include a crude topping unit, a visbreaker-vacuum unit converted from a Dubbs thermal cracking unit, and gas concentration and polymerization units. The poly unit was redesigned to produce 315 bpsd of 10-lb polymer.

Standard to Build New Type Fluid Catalytic Unit

Standard Oil Company (Indiana) has announced it plans to build a large new type fluid catalytic hydroforming unit —the first of its kind in the world—at its Whiting, Indiana, refinery.

A. F. Endres, refinery manager, said the 200-ft high unit will permit further improvement of Standard's motor gasoline. It will change 30,000 bbl a day of low octane naphtha into high octane hydroformate to be blended with other gasoline stocks, he explained.

M. W. Kellogg Company of New York City, the prime contractor, plans to start construction later this year. Completion is expected by the end of 1954.

New Unit for Sweeny Refinery

Phillips Petroleum Company has announced it will construct a new 16,000 bbl per day UOP Platformer unit at its Sweeny refinery in the Gulf Coast area south of Houston, Texas, to produce high-quality blending stock for greater output of high-octane gasoline for the new, more powerful automobiles. Construction, to be handled by Procon Inc., is expected to begin early next year with completion scheduled late in 1954.

Platformer Planned for SGHP's French Refinery

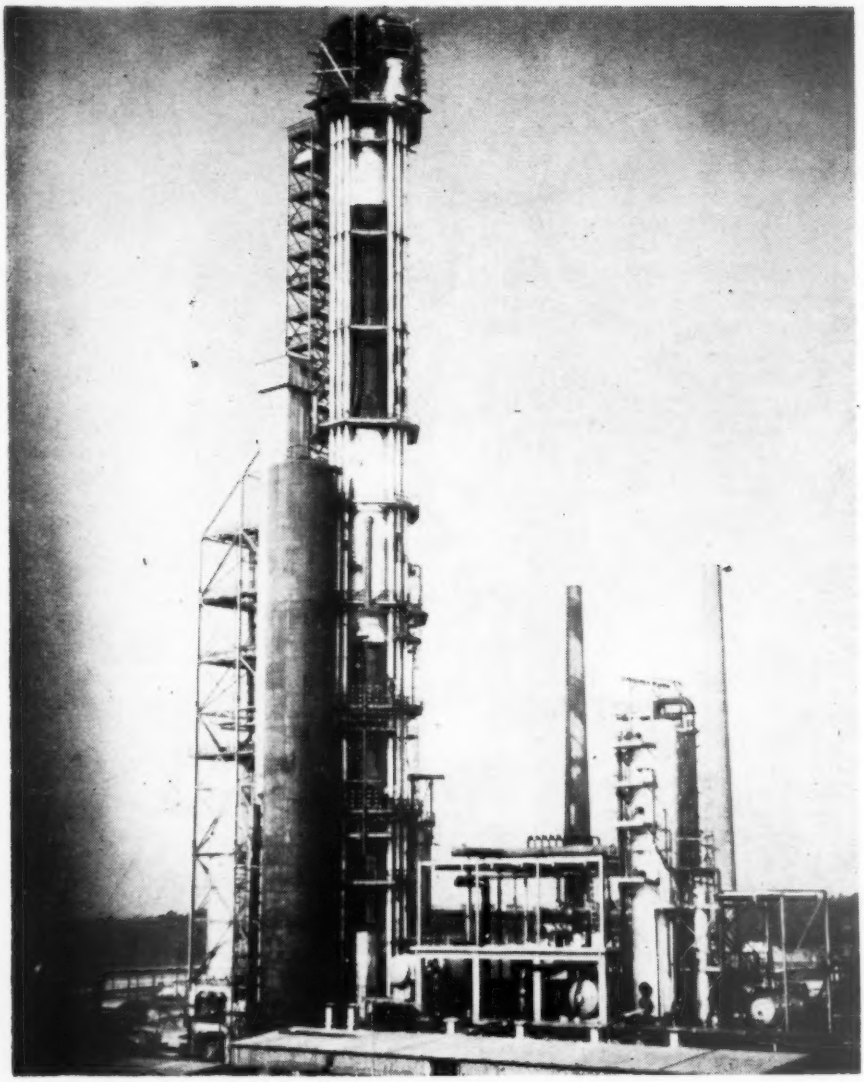
Work will begin shortly on the erection of a platformer with a capacity of 5000 bbl a day at Lavera refinery, owned by Anglo-Iranian's French associate, Societe Generale des Huiles de Petrole BP. The platformer—a twin to the unit being built at Anglo-Iranian's Hamburg refinery—will produce high grade motor spirit. Platformer was formerly planned for Dunkirk.

Apart from this platformer at Lavera, important new plant is being installed at three more of the six Continental refineries owned by Anglo-Iranian and its associates.

At Antwerp refinery (jointly owned by Anglo-Iranian and Petrofina) a catalytic cracking plant and a catalytic polymerization unit, which will produce high grade motor spirit, are being built.

At Hamburg refinery, a new distillation unit is being installed which will raise the plant's capacity to about 25,000 bbl a day. A platformer is also being built there.

Nearby, at the Schindler refinery, the output of high quality lubricating oils will be increased by the introduction of a new furfural treating plant.



FIRST GERMAN HOUDRIFLOW. Houdry Process Corporation's new Houdriflow catalytic cracking unit recently went on stream at Gewerkschaft Erdoel — Raffinerie Emsland refinery in Lingen, Germany. This large Houdriflow plant, financed partly with MSA funds and build largely with German labor and materials, is the principal processing unit in a completely new refinery.

Standard Indiana to Make Detergent Alkylate

Standard Oil Company (Indiana) is now in production of detergent alkylate—principal raw material for synthetic household detergents—in a recently completed plant at its Whiting, Indiana, refinery, it was announced by A. F. Endres, refinery manager.

The detergent alkylate is produced from benzene and propylene tetramer. The benzene is made synthetically from crude oil at Standard's Whiting refinery. The propylene tetramer, produced catalytically from refinery gas, is made for Standard at El Dorado, Arkansas, by Pan-Am Southern Corporation, a subsidiary. At Whiting the two raw materials are joined catalytically to produce detergent alkylate.

Cat Cracker Gets Underway

Construction work is progressing rapidly on an 11,500 bpd Houdriflow cat-cracker at Sun Oil Company's new refinery several miles outside of Sarnia, Ontario. This integral reactor-kiln type unit is designed to process gas oils from mixed Texas-Louisiana or Canadian crudes. The unit will circulate clay catalyst at a rate of 300 tons per hour.

Shell Lets Contract for Elk City Expansion

Contract for building the second major extension to Shell Oil Company's Elk City, Oklahoma, plant was awarded to The Fluor Corporation.

The decision for the plant's second extension was made earlier this year by the 14 companies in the Elk City unit. When completed some time during the spring of 1954, the extension will increase the plant's daily rated intake capacity of gas from 150,000,000 cu ft to 225,000,000 cu ft daily, and the gas injection capacity from 135,000,000 cu ft to approximately 210,000,000 cu ft per day.

In addition, it is anticipated that the plant's productive capacity of liquid products such as natural gasoline, butane, and propane will be increased approximately 50 per cent.

Cat Poly Unit Added To Texaco Refinery

Catalytic polymerization facilities will be added to The Texas Company's Sunburst, Montana, refinery, E. J. Scheibe, superintendent, announced. Engineering for the facilities is already under way. Materials and equipment are being obtained and when assembled construction will begin. It is expected that the new facilities will be placed in operation late this year.

The new unit will have an estimated capacity of 37,700 bbl per year of high octane blending stock.

Gasoline Plant Expanded

Skelly Oil Company announces the third expansion of its No. 2 gasoline plant at Eunice, New Mexico. Engineering and design have been completed by Skelly engineers; and construction, which is now underway, is under contract to the J. E. Carlson Construction firm. New facilities will permit processing an additional 20,000,000 cu ft per day of additional gas with the extraction of 60,000 gal per day of saleable liquid products, giving 260,000 gal of finished liquid products per day for Skelly's two plants in the area. Construction work is expected to be completed April, 1954.

Sunray Oil Plans To Upgrade Gasolines

Sunray Oil Corporation will build a 5000-bbl per day Platforming unit at its catalytic cracking refinery at Sunray Village (Duncan), Oklahoma. The company is currently receiving bids from contractors for construction of the unit which will be engineered by Universal Oil Products Company. The contract will be let in late September, construction begins about January 1, 1954 and the estimated completion date is in the third quarter of 1954.

The Platforming manufactures pure aromatic hydrocarbons such as benzene, toluene, etc., and also makes possible the manufacture of additional aviation gasoline base stocks. Capital investment will be approximately $1,000,000.

National Petrochemical Unit Underway in Illinois

The first step in the completion of National Petro-Chemicals' $44,000,000 project at Tuscola, Illinois, was taken recently when the hydrocarbon extraction and fractionation units of the plant began processing natural gas from the Panhandle Eastern Pipe Line Company's line, it was announced by Dr. R. E. Hulse, vice president of National Petro-Chemicals Corporation.

These units are said to comprise the largest plant in the world for the recovery of hydrocarbons from natural gas. When operating at full capacity, the plant will process 400,000,000 cu ft per day of natural gas and will have a daily output of 450,000,000 gal of natural gas liquids, i.e., propane, butane, isobutane, and natural gasoline.

COMPRESSOR CONTROL PROBLEMS?

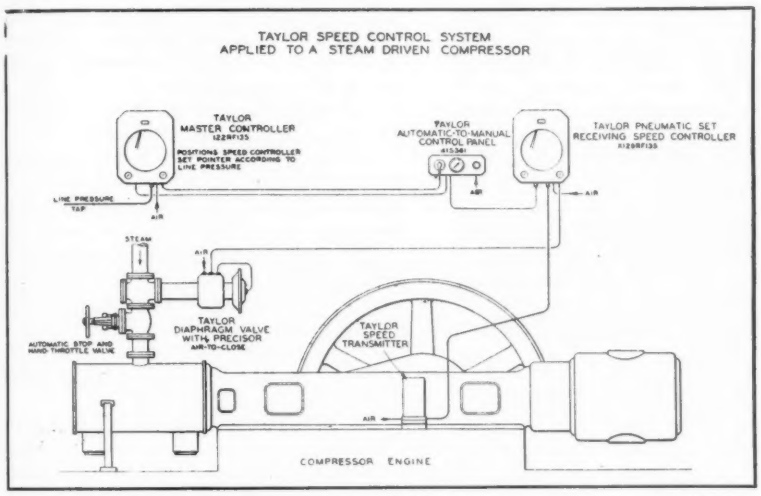
Taylor Speed Control gives better operating economy and processing quality for any type compressor or driver

Taylor Compressor Control Systems combine speed control to give you fully automatic control of compressors with direct relation to other variables in your process. These compressor control systems were developed by Taylor Engineers working hand in hand for years with leading compressor manufacturers and the ultimate user in refineries, gasoline plants and petro-chemical plants.

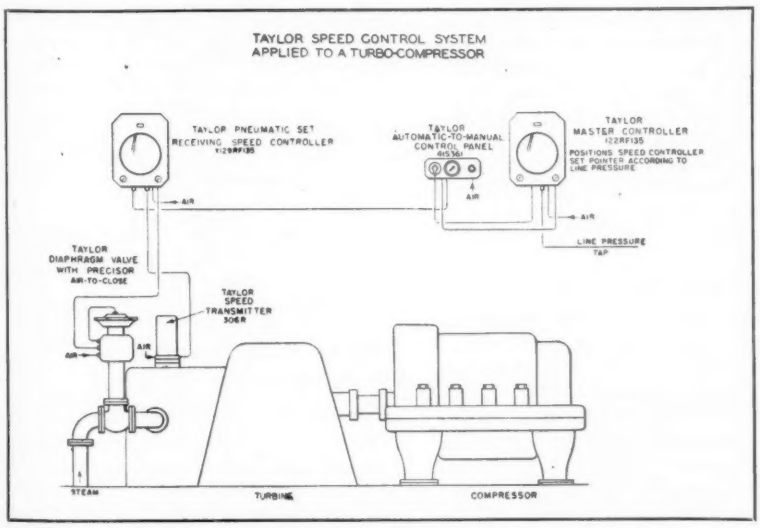
This all adds up to one important point. *When a compressor's function is closely controlled according to process requirements, substantial economies result from reduced fuel consumption as well as higher yields of quality end product.*

We can furnish a rugged, dependable control system for any type of driver and compressor combination. Ask your Taylor Field Engineer! Or write Taylor Instrument Companies, Rochester, N.Y., or Toronto, Canada.

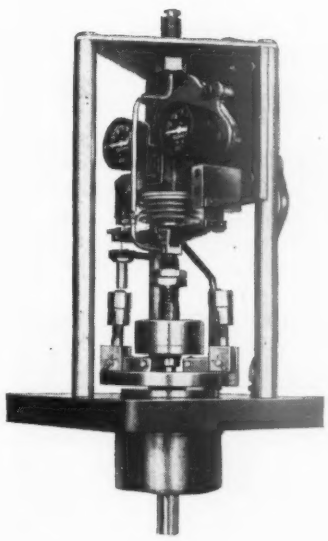
Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.



On this Reciprocating Compressor Speed Transmitter teams up with Taylor Pressure Controller, Pneumatic Set Speed Controller and Diaphragm Valve to maintain desired process pressure at minimum operating cost.



Applied to a Centrifugal Compressor equal benefits are derived from this control system. Fuel consumption is held to a minimum, consistent with the maintenance of optimum process pressure.



Taylor Speed Transmitter permits use of standard controls!

Here's how it works:

It is a dependable force-balance transmitter working in combination with a Taylor FULSCOPE* pneumatic controller. The fly-ball operated transmitter is driven by the compressor and converts engine speed directly to output air pressure proportional to the square of the speed. This signal is received by a Pneumatic-Set FULSCOPE Controller which regulates the fuel valve to give desired speed control. Processing pressure requirements—measured and controlled by the master controller—determine the speed controller set point.

*Reg. U. S. Pat. Off.

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

Union Tests Oil Shale For Brazilian Government

Union Oil Company of California is doing pilot shale retorting tests for the Brazilian Government at its Wilmington refinery. Approximately 300 tons of Brazilian oil shale will be processed to determine if an 8000-bbl per day plant near Sao Paulo, Brazil, using Union Oil's retort design would be practical.

Dr. Clyde Berg, Union process development manager, announced that if the plant is constructed, it will be the first commercial shale oil plant in the Western Hemisphere.

Pure Oil to Install New-Type Reformer

Pure Oil Company has contracted with The M. W. Kellogg Company for the design and erection of a catalytic reformer at its Heath (Ohio) refinery. The plant will employ the recently disclosed Sinclair-Baker platinum catalyst.

Pure Oil is the second company to announce its decision to build a plant using the new catalyst, a material which has three major advantages for petroleum refiners. Because it is a regenerative type, the new catalyst maintains its high activity over extremely long periods of time, resulting in low catalyst costs. It also has excellent ability to convert low octane paraffinic components to high octane aromatics. And finally it may be employed on a wide variety of feed stocks.

GLASSES & GASKETS

ALL SIZES TO FIT YOUR GAGES & VALVES
ERNST WATER COLUMN & GAGE CO.
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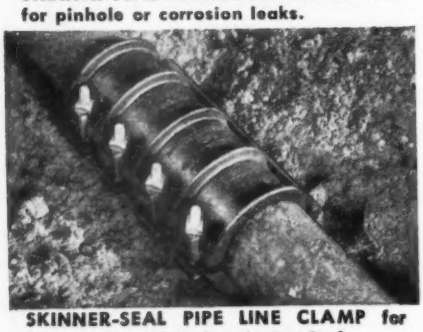
TO REPAIR PIPE LEAKS – QUICKLY, PERMANENTLY
ANY PRESSURE — ANY TEMPERATURE

SKINNER-SEAL EMERGENCY PIPE CLAMP for pinhole or corrosion leaks.



SKINNER-SEAL PIPE LINE CLAMP for long splits and bad corrosion leaks.

In stock—all supply stores

M. B. SKINNER COMPANY
SOUTH BEND 21, INDIANA, U. S. A.

Jefferson Builds New Lab

Jefferson Chemical Company, Inc., has announced the completion of a major addition to its research laboratories at Austin, Texas. The new facilities, comprising two air-conditioned, interconnected brick and concrete buildings, provide upwards of 25,000 sq ft of additional floor space. The smaller of the two buildings houses the library and administrative offices, and the other contains fully-equipped laboratories to accommodate about fifty research chemists and technicians.

Suntide Refinery Completed

Suntide Refining Company has fired up its crude oil processing stills for the production of gas oil at its nearly completed catalytic cracking refinery in Corpus Christi, and is running ahead of schedule in completion of principal oil processing units.

Sunray Oil, a 50 per cent owner of the Suntide refinery stock, began the delivery of crude oil to the new plant's oil storage tanks during early July. The gas oil stock now being processed is going into storage pending completion of other facilities at which time it will be the charging stock for catalytic cracking unit.

Esso's Cat Unit Sets Record

A record 19,336,700 bbl of total feed were processed by Esso Standard Oil Company's Baton Rouge's PCLA-3 fluid catalytic cracking unit in the year ending July 13, 1953.

This is the highest annual throughput ever achieved by a Jersey Standard Model II unit. The plant was originally designed for 15,000 bbl per day, and completed 10 years of service on June 25, 1953. The past year's throughput, achieved through expansion and bottleneck removal, represents a daily average for the year of 53,000 bbl per day. The highest feed rate reached for any one day was 68,300 bbl per day on May 26, 1953.

New Asphalt Plant Set

American Bitumuls and Asphalt Company of San Francisco, California, has announced plans for construction of a $4,000,000 asphalt refinery near Cincinnati, Ohio. C. W. Turner, president of the company, said the plant will be built on a newly-acquired industrial tract on the Ohio River at Miami Ford.

Turner said the refinery will be especially designed for the refining of asphalt products and the manufacturing of all standard grades of asphaltic products used by the paving industry for roads, streets and airports, and for bituminous maintenance of all kinds.

Sunray Produces Alkylates At New HF Plant in Duncan

Sunray Oil Corporation has begun the production of 1500 bbl per day of high octane aviation alkylates at its Sunray Village refinery in Duncan, Oklahoma.

The start-up of Sunray's new $1,700,000 HF alkylation plant was almost simultaneous with request of the Petroleum Administration for Defense that the nation's oil refiners increase the production of this vital fuel needing increased supply by the air branch of the Armed Services.

Alkylate is the refined petroleum product that puts extra energy into the gasoline used by propeller-driven airplanes. The refining industry's output of this material is generally behind PAD goals, a spokesman for the department declared in Washington last week.

National Lubricating Grease Institute Tentative Program

Tentative program, annual meeting, National Lubricating Grease Institute, October 26-28, 1953, Edgewater Beach Hotel, Chicago, Illinois.

"To Mix or Not to Mix," Melville Ehrlich, American Lubricants.

"Evaluation of Wheel Bearing Grease Performance," P. H. Holt, II and H. L. Leland, Esso Laboratories, Standard Oil Development Company.

"Some Unique Developments and Studies in Lubricating Grease Research," L. C. Brunstrum, Standard Oil Company (Indiana).

"Your Obligation to Marketing," W. H. Garbade, president, Deep Rock Oil Corporation.

"The Performance and Testing of Lubricating Greases Under Wet Operating Conditions," J. D. Smith, International Lubricant Corporation.

"Oxidized Petroleum Wax as a Grease Base," Dr. J. C. Kirk and E. W. Nelson, Continental Oil Company.

"Desirable Characteristics of Lubricating Greases for Electric Motors," Dr. E. R. Booser, General Electric.

"Soap Dispersion and Colloidal Structure in Lubricating Greases," NLGI Fellowship Report, Valeria Elersich, University of Southern California.

"Some Aspects of the Preparation of Bentone Greases," Dr. Robert E. Fariss, research and development department, National Lead Company.

(Title to be announced), Ole Berg, Jr., president, British-American Oil.

Taylor Puts Second Platformer on Stream

Taylor Oil and Gas Company recently put on stream its second UOP Platformer. The new unit has a design charge capacity of 5000 bpsd of reactor charge. Universal Oil Products Company designed and licensed the installation. Taylor Oil and Gas Company constructed the unit. Taylor's other UOP Platformer, a 4000 bpsd unit, went into operation December 10, 1951, at its Port Isabel, Texas, refinery.

LP-Gas Safety Rules Released by NGAA Group

Safety precautions for truck loading of LP-Gas have just been released by the Safety Committee of the Natural Gasoline Association of America. Written primarily for the supervising loader at loading racks, responsibility for the safe loading of trucks is placed squarely on the loader and the truck driver is relieved of all duties other than spotting his vehicle as directed. The cards are printed in two sizes, letter size for posting at loading racks and postcard size for posting in truck cabs. They are available from the offices of the NGAA, 422 Kenendy Building, Tulsa, at four and two cents each respecively.

SAFE PRACTICES
for
LOADING LPG INTO TANKS TRUCKS
as recommended by
NATURAL GASOLINE ASSOCIATION OF AMERICA

The loader shall see that all truck papers and tank capacity gages comply with state and I.C.C. regulations.

No smoking, open lights or flames permitted in loading area.

Maintenance or repair work shall not be permitted on vehicle while loading is in progress.

THE LOADER SHALL:

(1) Remain in attendance at all times during loading operations except for necessary operations connected with loading.
(2) See that driver properly spots truck, sets brakes, shuts off engine, radio and lights, and leaves cab.
(3) Place wheel chocks in front and back of a rear whel.
(4) Fasten ground devices properly to clean unpainted surface of the tank to provide metal to metal contact.
(5) Make ALL hose connections.
(6) Recheck all hose connections before opening valves and starting pump.
(7) Set gaging device to not exceed maximum permitted volume and proceed to load.
(8) Be responsible for adding of odorant when required.
(9) If leak develops, shut down operation and repair before proceeding with loading.
(10) After loading is completed, close valves and bleed pressure from hose before disconnecting.
(11) Disconnect hose ground devices and remove chocks.
(12) Give driver clearance for safe removal of truck.

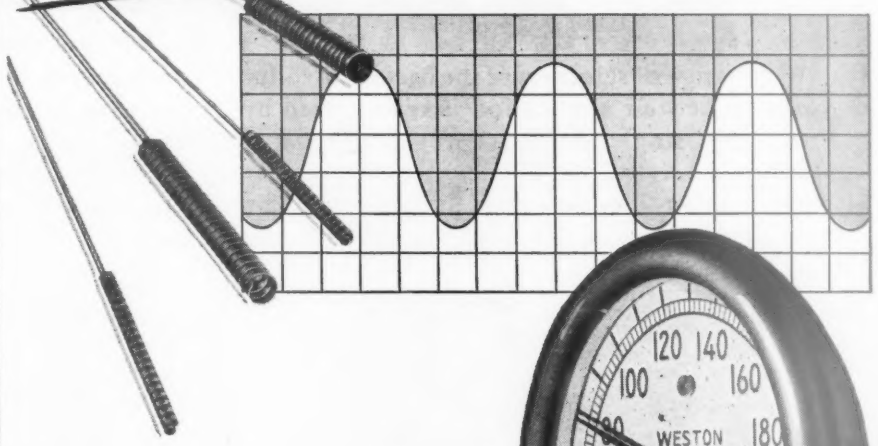
Sinclair Fractionating Unit

A new gasoline fractionating unit for the East Chicago refinery is being planned by Sinclair Refining Company, according to an announcement by W. R. Argyle, vice president.

The new unit will have a nominal capacity of 20,000 bbl daily and, will enable the company to produce higher octane gasoline.

Contracts for construction will be let and it is anticipated that work will begin late this fall and will be completed early in 1954. Estimated cost of the project is $1,300,000.

Cycle-Seasoning...



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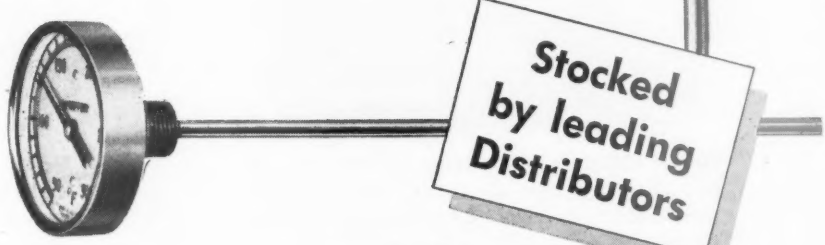
To INSURE accurate functioning over long periods, a bi-metal sensing element must necessarily be aged. But there's a big difference in the aging methods employed! Each element in a WESTON Thermometer is first WESTON made . . . then placed in a chamber and subjected to *broad range cycle seasoning* for prolonged periods. When finally placed in a thermometer it is *fit* and *ready* to give the precise measurements . . . the long-term dependability . . . so typical of all instruments bearing the WESTON name. WESTON Thermometers are available in all types, sizes, ranges and stem lengths for all industrial applications. Literature available . . . WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

Thermometers with the MULTIPLE HELIX



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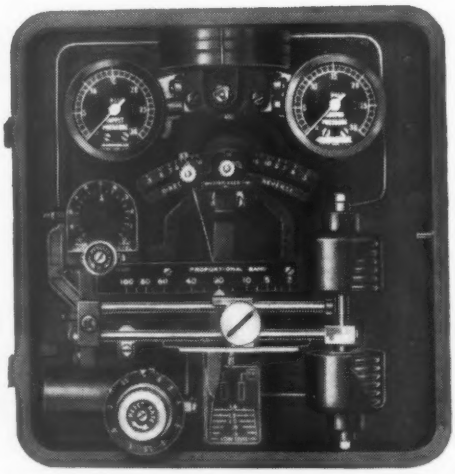
WESTON *Thermometers*

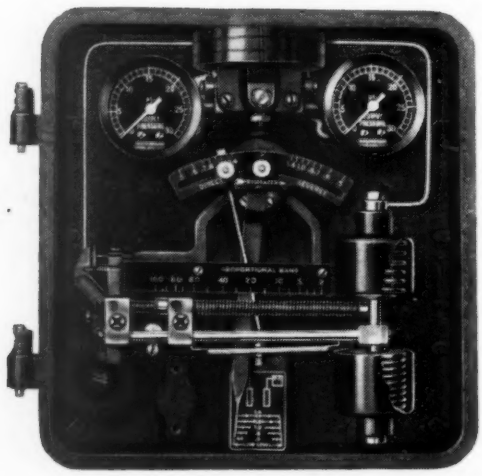
6 Reasons

Wide range of selection of the basic controller unit to fit your application is represented by the five single-unit controllers illustrated below . . . five of the many reasons why Masoneilan Liquid Level Controllers offer you more for your money. The sixth is the convenience of grouping any two of these in one case as illustrated in the model to the right. This range of selection enables you to obtain from *one* manufacturer the control equipment for almost any liquid level application.

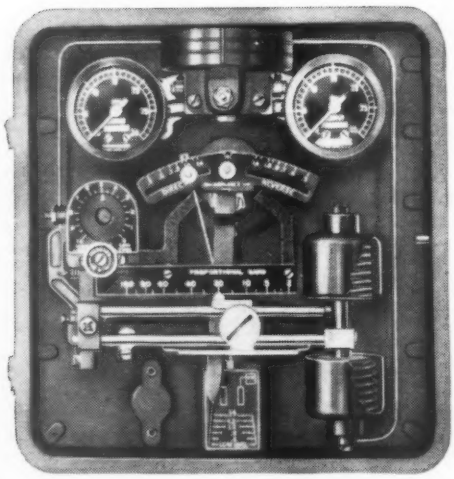
Model 12800 — The basic proportional controller; may also be used as a transmitter; may be converted in the field to a differential gap controller.



Model 12810 — Adds reset action to the proportional controller. Conversion of Model 12800 may be accomplished in the field if desired.



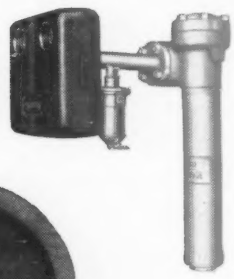
Model 12820 — The pneumatic transmitter provides an output air signal which is proportional to level changes, for indication, recording or control.

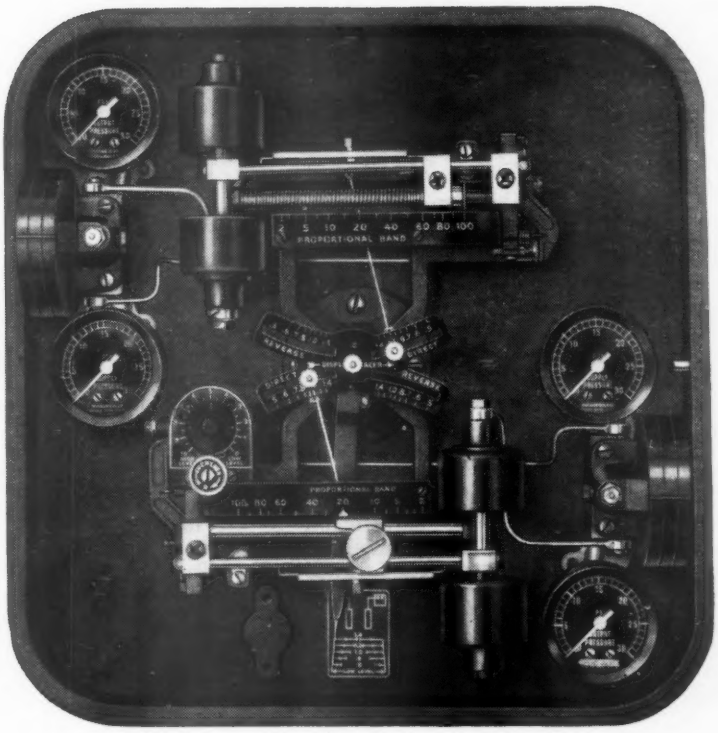


Model 12830 — The differential gap controller. May be converted to a proportional controller in the field if process changes require it.

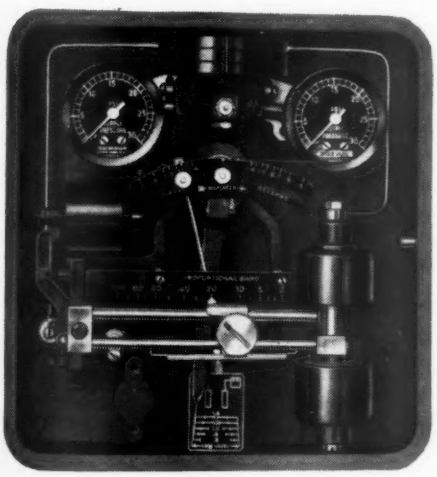
TWENTY POSSIBLE

Why You Should Select Masoneilan Level Controllers





Model 12800-20 — A duplex model grouping the proportional controller and pneumatic transmitter. Any combination of two identical or dissimilar single units is possible — a total of fifteen combinations.



Model 12840 — The pneumatic set controller provides for remote adjustment of set point. Available with either proportional or proportional-reset action.

Simplicity of design; sensitive accuracy of control; wide choice of materials; ease of maintenance; convenience of installation; and sturdy, long lasting construction are six *other* reasons why you should select Masoneilan 12000 Series Liquid Level Controllers.

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INSTRUMENT COMBINATIONS

XUM

Toxological Reviews Out

Availability of another series of toxological review of substances used or produced in the oil industry was announced by the American Petroleum Institute.

Latest series contains toxological reviews on 31 substances, ranging from acetic acid to triethanolamine. This series is a supplement to the two series issued in 1948, so that the Institute now has available toxological reviews on 63 substances. These are listed on a leaflet which may be obtained upon request to API.

India Refinery to Be Built for Burmah-Shell

A new oil refinery with a yearly throughput of 14,000,000 bbl is being built at Bombay, India, by the Burmah-Shell Refineries Ltd. a new company jointly owned by Shell Petroleum Company and the Burmah Oil Company. Estimated cost is $56,000,000. Company was incorporated in India.

Construction contract has been awarded to the Lummus Company, New York, who also participated in the refinery's design in association with Shell engineers.

Plant will process Middle East crudes and its output will supply a considerable part of India's gasoline, kerosine, diesel oils, furnace fuels and bitumen requirements. It will be largest in India when completed.

Main refinery plant will comprise crude distillation, vacuum distillation, catalytic cracking, gas separation, product treating, bitumen manufacturing and packing units.

An existing loading and unloading facilities on Trombay Island, where the plant is located, will be insufficient for the combined use of various oil companies, the Bombay Port Trust is building a new marine terminal at Butcher Island. It is three miles from Trombay. Islands will be connected by submarine pipe lines. Crude oil will be pumped through these lines from Butcher Island and part of the refined products will be pumped back the same way to tankers for distribution to coastal oil stations.

A part of the oil will be piped directly to distributing company's installations in the Bombay area, and the remainder will be distributed by rail and road to various bulk depots.

Salt water will be used for cooling and south of Trombay Island a small electrically powered pumping station is to be built. These pumps will supply water to a basin from which main cooling water pumping station will take its supplies. To safeguard production in the event of electrical failure a standby steam driven generator will be installed in main refinery. Main pumps are to be turbine driven. Electricity is to be supplied by the local companies.

Refinery is to be managed by Herbert James Trow. He has been with Shell since 1929 and has served in Mexico and Egypt.—C. M. J.

REFINING AND PETROCHEMICAL PERSONALS

D. K. Harger

▸ **D. K. Harger** has been named general manager of the Standard Oil Company of California refinery at El Segundo. He succeeds the late C. A. Pollard, who held the position for two years until his death last month.

Harger, who has been manager of operations at the El Segundo refinery since 1946, joined Standard in 1926, after receiving a degree in chemical engineering at Stanford.

Transferring to the manufacturing department in 1934, Harger progressed steadily through a series of increasingly responsible positions until 1942, when he transferred to the company's refinery at Richmond as superintendent of process control. After several years in Richmond he returned to El Segundo as manager of operations.

▸ **A. P. Lien, G. M. Webb, A. W. Lindert** and **J. F. Snuggs** have been appointed assistant division directors, a newly-created post in the Whiting, Indiana, research laboratories of Standard Oil Company. Dr. Lien will serve in the chemical products division, Dr. Webb in the hydrocarbon research division, Lindert in the heavy oils products division, and Snuggs in the process division.

Other promotions in hydrocarbon research include **Dr. C. E. Johnson** and **Dr. H. S. Seelig,** named section leaders, and **Dr. W. A. Wilson,** group leader.

Dr. W. C. Edmister has been advanced to group leader in heavy oil products.

In the process division, **J. A. Bock** was appointed section leader and **Joseph Gurawitz,** group leader.

Dr. Lien received master's and doctor's degrees at Ohio State University. He joined Standard in 1941.

Dr. Webb was awarded MS and PhD degrees at Washington University. He served as a research associate with Standard, starting in 1948.

Lindert, a University of Minnesota graduate, served in Standard's sales technical service department from 1940 until 1947. He advanced to section leader last year.

Snuggs received his master's degree in chemical engineering at Massachusetts Institute of Technology. Joining Standard in 1938, he was named section leader in 1948. Dr. Johnson received MA and PhD degrees at Kansas University. Joining Standard as a chemist in 1951. Dr. Seelig received his MS from Georgia School of Technology and his doctorate from the University of Minnesota. He joined the company in 1946 and was promoted to group leader in 1950. Dr. W. A. Wilson, a University of Akron graduate, received his advanced degrees at Pennsylvania State College and joined Standard as a chemist in 1950.

Dr. Edmister received his doctorate from Ohio State University. He began as a Standard Oil chemist in 1949. Bock, a Purdue University graduate, was awarded a master's degree at MIT. Joining Standard 10 years ago as a chemical engineer, he became a group leader in 1948. Gurawitz, a graduate of the University of Pennsylvania, has been a chemical engineer with Standard since 1947.

▸ **Sixto Acuna,** chemical engineer from Manila, is believed to be the first Filipino to receive on-the-job training in an American refinery. He came to the United States through the sponsorship of Sun Oil Company in co-operation with the U. S. State Department. Acuna had never seen a refinery until his arrival in May. In two years he will return to his native land with practical petroleum technology, plus an understanding of human relations as practiced in American industry.

▸ **Frank M. Perry** of Bartlesville, vice president in charge of natural gasoline and chemical operations for Cities Service Oil Company, has been appointed a member of the American Petroleum Institute's General Committee on refining. Perry, who is president of the Natural Gasoline Association of America, will serve with W. T. Gunn, who is director of the API's refining division.

▸ **Dr. Arnold O. Beckman,** Beckman Instruments, Inc., has established a major award honoring U. S. and Canadian scientists for work in chemical instrumentation.

To be first presented in the spring of 1955, the $1000 annual award will recognize outstanding achievements in the development of new instruments for chemical analysis and the application of instruments to chemical process measurement and control.

Administered by the American Chemical Society, the Beckman Award will give special consideration to originality as well as the value of the contribution in reducing manufacturing costs or improving product quality.

IN THIS ISSUE—

Dispatchers of Northeastern Gas Transmission Company have solved the problems of "shaving" and "peaking" through use of telemetering and remote control of gas flow. Compensations for increased demand resulting from rapid changes in outdoor temperatures can now be made easier and faster by dispatchers with the new equipment, which has been in operation for a year and promises to be even more effective this coming autumn and winter. (See page D-4).

In determining the efficiency of a centrifugal compressor, it's best to decide first which efficiency you are looking for—there are three choices. Actually, there are four different efficiencies: Polytropic, adiabatic, overall adiabatic shaft, and isothermal. The latter applies only to cooled compressors. Adiabatic and polytropic efficiencies are usually purely hypothetical operations. The best picture is provided by the adiabatic shaft efficiency. A formula for determining this efficiency is given in the article. (See page D-11).

Overheated motors can cause a great deal of trouble in pipe line operations. Explosive atmospheres and other considerations often require that protective relays be located in areas remote from the motors they protect. Separation of motors and relays may mean different and varying ambient temperatures—a stumbling block in proper thermal protection of motors. The author describes the types of thermal relays available, and how to select them through consideration of motor functions and the effects of ambient temperature variations. (See page D-14).

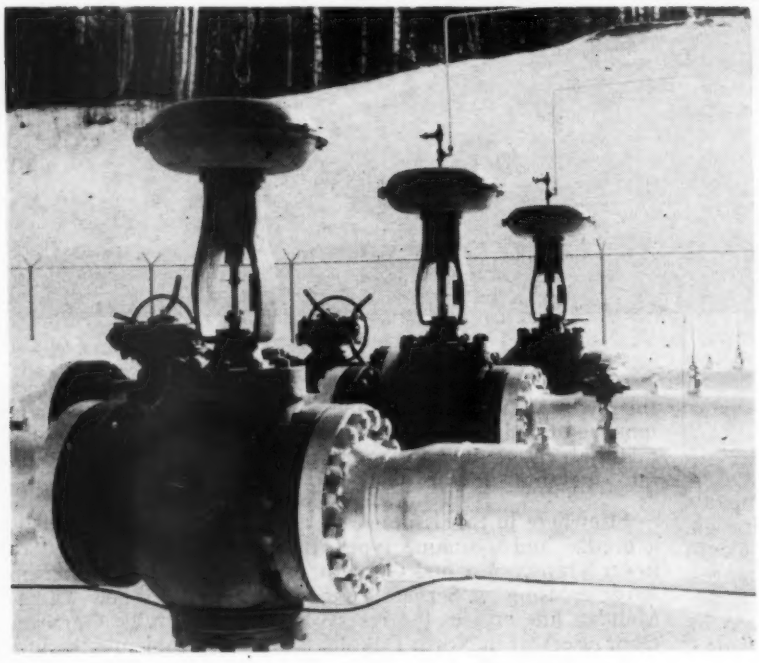
Puzzled by tank moving operations? Union Oil Company engineers solved their particular problem by employing an age-old and simple—but unique—principle. They merely floated the tank to its new location. They also saved approximately $55,000 and considerable time through their unusual methods.

Few natural gas transmission companies can afford to raise line pressures to overcome loss efficiency due to design code limitations since most lines are designed to operate at maximum pressure on initial load. A better way is to continually keep the gas lines clean during operation through use of scrapers. Improved efficiency at lower cost is possible by this method. Not only are lines better maintained, but maintenance of compressor stations is reduced because less foreign material enters operating equipment after the line is put into operation. (See page D-19).

Elsewhere in this issue: A special underwater jet trencher, a dredge and a unique type of roller-weight were used to lower Transcontinental Gas Pipe Line Corporation's Hudson River crossing . . . Service Pipe Line Company's new Tioga-Mandan line crosses the reservoir bed of the huge Garrison Dam reservoir in North Dakota, but it's no problem—the line is being laid before the reservoir is filled . . . FM radio has limited range because of operating characteristics. A mobile tower, which extends to 80 ft and collapses to 24 and is carried on a light trailer, can solve the problem.

FIG. 1. West Lebanon, New York, metering station.

FIG. 2. Diaphragm-operated valves on meter runs at the West Lebanon station.



The Author

Walter E. Rufleth, application engineer with The Bristol Company, Waterbury, Connecticut, has an electrical engineering degree from Rensselaer Polytechnic Institute and is a registered professional engineer in the state of Connecticut. Since 1935 he has been associated with The Bristol Company in various capacities as product and development engineer. At the present time he is connected with the application engineering department, responsible for the application and use of telemetering, remote control equipment, and electrical measuring instruments.

Telemetering and Remote Control of Gas Flow

By "shaving" and "peaking" Northeastern Gas Transmission Company dispatchers operate system efficiently, economically

WALTER E. RUFLETH

For many years residents of New England have viewed with envy the huge natural gas fields of the southwest. True, New England had gaseous fuel in the form of manufactured gas, but the quantity was quite limited. Scarcity and cost delayed and minimized the use of gas for space-heating and industrial use. The answer to this problem was natural gas.

To tap the tremendous supplies of natural gas available at the well and to transport it from the southwest to New England constituted a major task, but the pipe line companies have done this. Tennessee Gas Transmission Company, with its vast transmission system, brought gas to the doorstep of New England, but it remained for Northeastern Gas Transmission Company to be the first to bring natural gas to the homes and industries of New England.

Northeastern's pipe line starts at the New York-Massachusetts boundary, where it connects with Tennessee's line, and extends across the state of Massachusetts with laterals reaching into New Hampshire and Connecticut. This pipe line acts not only as a transmission means, but has considerable volume so that it can be used for storage purposes as well.

If steady-state conditions of load existed at all times, it would be a simple matter to control and operate such a pipe line, but this not the case. For example, consider the large load change that occurs due to space-heating when there is a rapid change in outdoor temperatures. Because gas travels relatively slow through a pipe line, it is often necessary to anticipate changes in load and make adjustments such as "packing" and "shaving." These duties are usually handled by the gas pipe line dispatcher.

To aid its dispatchers, Northeastern

EXCLUSIVE

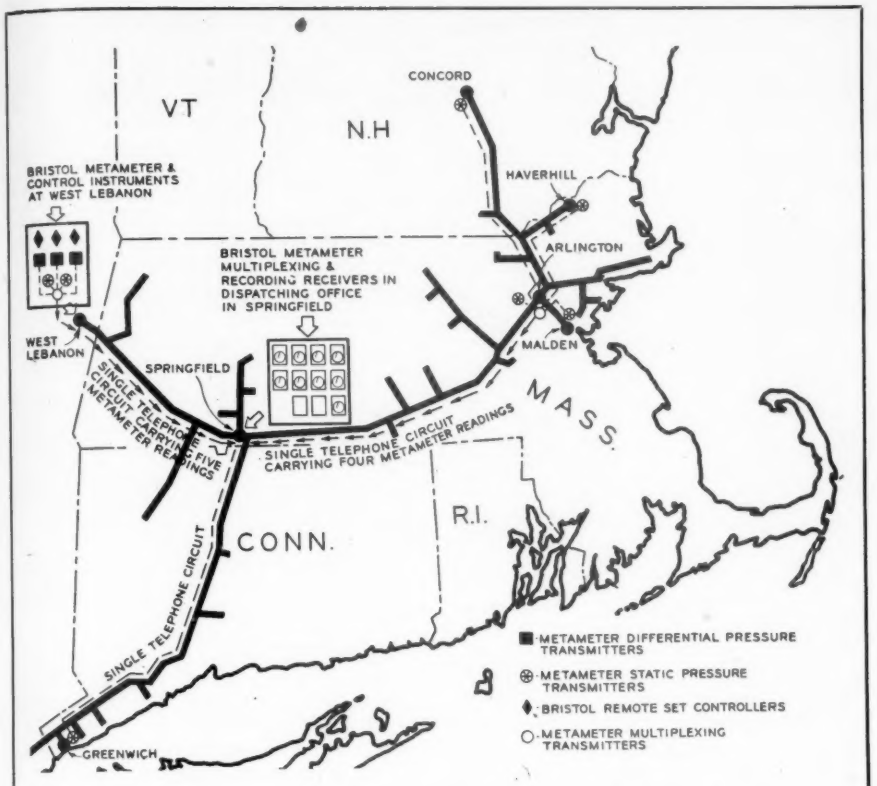


FIG. 3. Northeastern Gas Transmission Company pipe line showing multiplexed telemetering and remote control.

Gas Transmission Company has provided telemetering between the West Lebanon, New York, metering station and the Springfield, Massachusetts, dispatch station. Automatic controllers at West Lebanon can also be set from Springfield. Telemetering is provided between Greenwich, Connecticut; Concord, New Hampshire; Arlington, Haverhill, and Malden, Massachusetts, and Springfield. (See map of system. Fig. 3).

All gas supplied to Northeastern passes through the metering station at West Lebanon, where Tennessee's pipe line and Northeastern's connect. Fig. 1 shows the West Lebanon station. This station is at present a three-meter-run station with facilities for installing additional runs. In conjunction with the billing meters and temperature recorder are three differential pressure telemeter transmitters, one connected across the orifice in each of the three runs. Each meter-run also has a diaphragm-operated valve for controlling flow of gas. (See Fig. 2.) Valves are actuated by the outputs of the three differential pressure automatic controllers of the reset type, the setpoints of which can be changed by the dispatch station at Springfield. At the West Lebanon station, there are also two telemeter transmitters, one for static pressure and the other for transmission of pressure downstream from the above-mentioned valves. At each of the other metering stations mentioned, namely, Greenwich, Concord, Arlington, Haverhill, and Malden, are telemeter transmitters measuring the gas pressure supplied to the customer distribution companies, and transmitting these to Springfield.

Fig. 4 shows the dispatcher's room at Northeastern's main office in Springfield, Massachusetts. The dispatch panel includes round-chart telemeter recording receivers and two time-multiplex receivers. Also situated at Springfield but not shown in Fig. 4 is a control dial for changing set-points of automatic controllers located at West Lebanon.

All transmission of telemeter signals and remote control is over circuits leased from telephone companies. The circuit between West Lebanon, New York, and Springfield, Massachusetts, and Greenwich, Connecticut, and Springfield are supplied by the long lines department of the American Telephone and Telegraph Company. Circuits between the other metering stations and Springfield are provided by the New England Telephone and Telegraph Company.

To transmit the five telemeter signals and three remote control functions between West Lebanon and Springfield would normally require eight individual circuits. Likewise, to transmit the four functions from the eastern portion of the system to Springfield would require four more circuits. This would tie up a considerable number of long distance telephone circuits and, economically speaking, would be quite an item. The use of time-multiplex equipment simplified the problem and also allowed the use of low-priced circuit rental facilities recently made available by the telephone companies.

Fig. 5 shows a typical time-multiplex transmitter such as those at West Lebanon and Arlington. The five telemeter transmitters at West Lebanon are connected to a time-multiplex transmitter, and the signals transmitted over a single circuit to Springfield, where a time-multiplex receiver discriminates the signals, actuating the individual telemeter receivers. The readings from Concord, Haverhill, and Malden are brought to Arlington on individual circuits, and multiplexed from there, along with the local Arlington reading, over a single circuit to Springfield. There the other time-multiplex receiver actuates additional telemeter receivers. Fig. 6 is a time-multiplex receiver such as used at Springfield. The time-multiplex operates on a time-sequential basis, and is designed so that additional telemeter facilities may be transmitted at any time. The multiplex equipment, as well as the telemetering and remote control equip-

FIG. 4. Dispatcher's room at company main office, Springfield, Massachusetts.

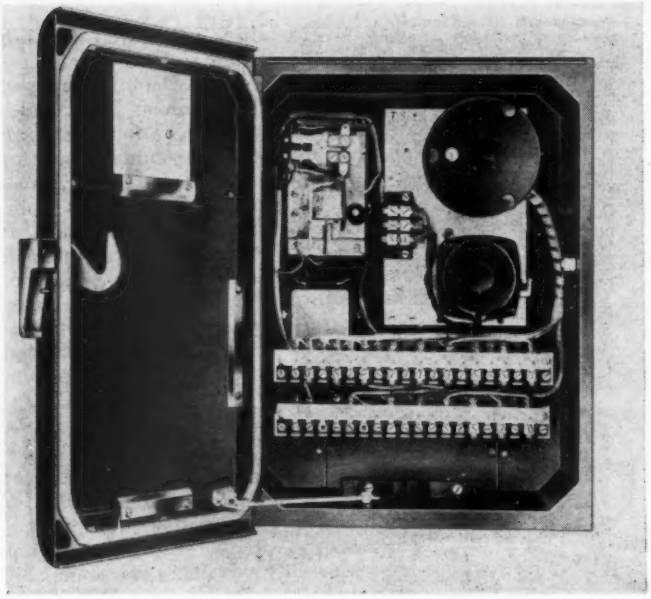


FIG. 5. Time-multiplex transmitter.

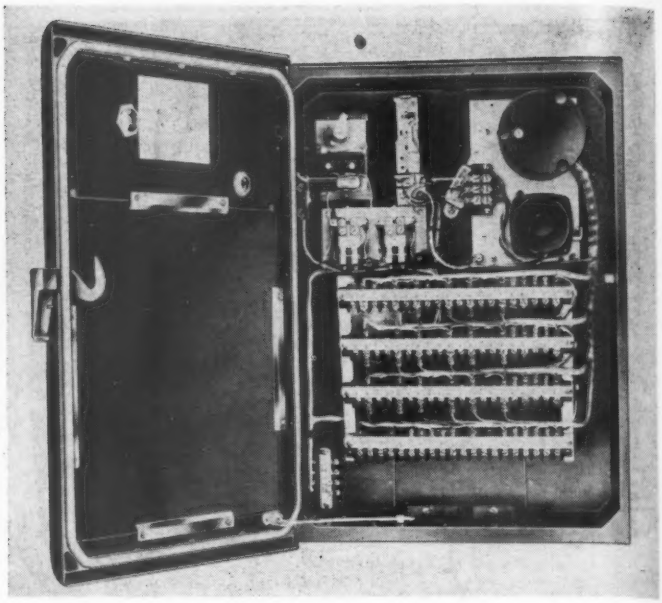


FIG. 6. Time-multiplex receiver.

ment, was manufactured for Northeastern by The Bristol Company of Waterbury, Connecticut.*

Changes of the controller set-point at West Lebanon by the Springfield dispatcher is accomplished by dial selective equipment supplied by the American Telephone and Telegraph Company. The dispatcher has six five-digit numbers that he may dial on a telephone-type dialing arrangement. Three of these numbers are for "raising" the set-points of the differential pressure controllers (one for each meter-run) and three for "lowering" the set-points. The dispatcher is also provided with a "disconnect button," which he may use at any time to discontinue the operation being carried on, and to institute a new one. At West Lebanon, a selector, which may be referred to as a discriminator, closes the proper contacts in accord with the desired operation and actuates a reversible motor in the automatic controller to change its set-point. A limiting device allows only a certain amount of change with one dialing operation, thereby preventing any disastrous effects due to incorrect dialing. Further changes require additional dialing. The same line that brings the telemetering signal into Springfield is also used to send the control set-point signals in the opposite direction. This is possible by making use of a duplex circuit.

Telemetering and remote control equipment described in this article was installed last fall. Since then, and especially during the colder winter months, it has helped Northeastern dispatchers to operate their system at peak efficiency and most economically by "shaving" and "peaking" in accordance with load conditions. * * *

*For details on telemetering and remote control, see "Remote Measurement and Control" in the October, 1952, issue of *The Petroleum Engineer*.

Whodunit?

Shell Pipeliners Have Mystery

Scraper Turns Up Railroad Jack

Pipe line scrapers — also known as pigs and go-devils — are used principally to clean out paraffin and other oil sediment that tends to clog the lines.

And, as all real pipeliners know, these scrapers push out other things — surprising things such as rabbits, snakes, rats, fence posts, log chains and even skids — goodness knows how they find their way into the lines.

When the last scraper was run through Shell Pipe Line Corporation's McCamey-Houston 10-in. line shortly before it was closed down, no one was really surprised that it brought forth an 8-ft, 2- by 4-in board at Fredericksburg.

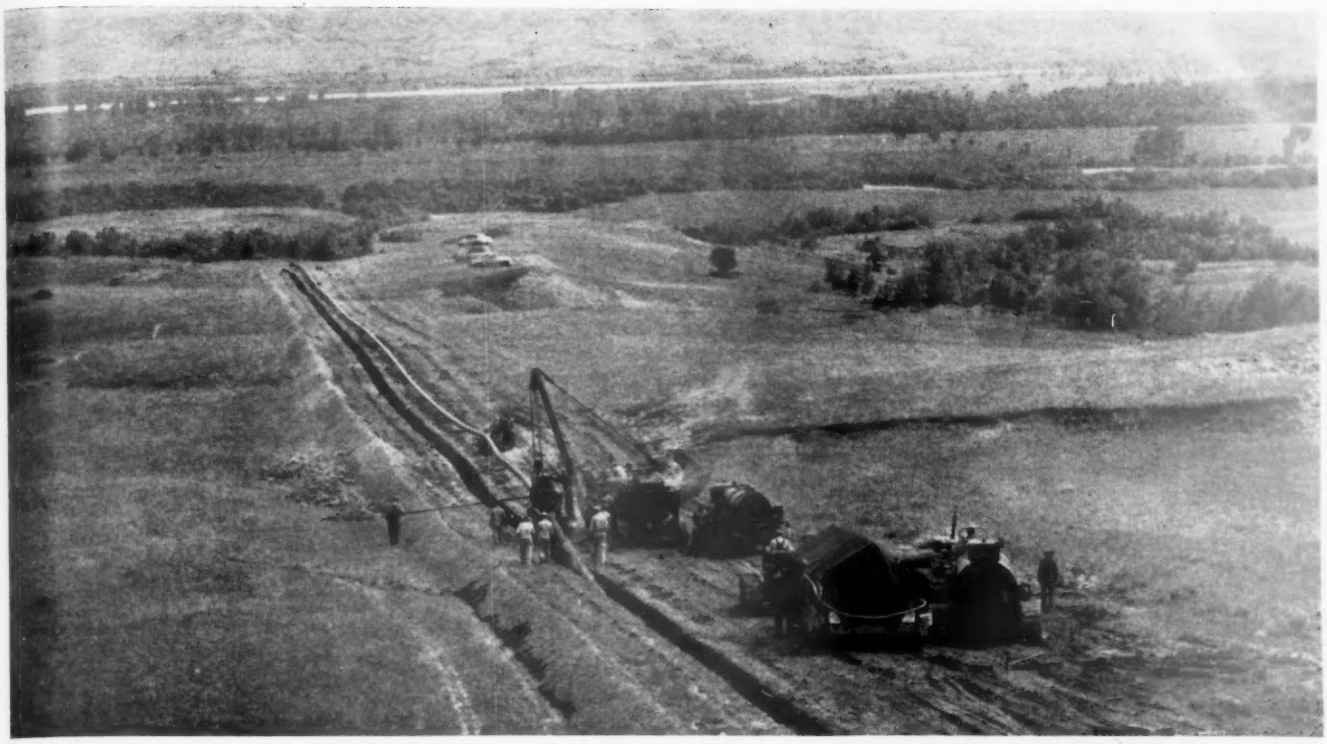
But . . . when the scraper reached Brookshire shoving an honest-to-goodness railroad car jack . . . well, that was something new.

Nope, no one has explained yet how a car jack can get into pipeline.

—*Courtesy The Go-Devil*

The Evidence

P 615.371.



COATING and wrapping crew and lowering-in crew at work on the 12-in. line near Missouri River. Water 70 to 80 ft deep will cover area in background when Garrison Dam reservoir is filled.

80 Feet of Water to Cover

Long Underwater River Crossing

Constructed on Dry Land

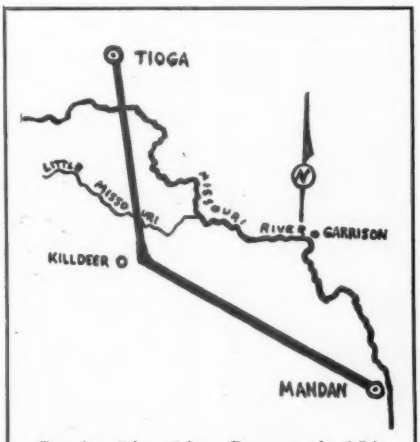
Service Pipe Line Company's new Tioga-Mandan line crosses Garrison Dam reservoir, and two rivers in its 154-mile route across North Dakota

EXCLUSIVE

THE mighty Missouri River and the giant Garrison reservoir are serious obstacles in the path of North Dakota's first crude oil pipe line. Their presence, however, has not impeded the construction progress of a 154-mile line being built by Service Pipe Line Company to aid the state's expanding oil industry.

Lines in the bed of the future reservoir and the river channel and across the Little Missouri River have been laid by Service.

The line that traverses the bed of the reservoir to be filled by Garrison Dam, one of the world's largest earth fill dams currently being constructed at Garrison, North Dakota, will eventually be covered by 80 ft of water. The huge lake that will be made by backing up Missouri River waters will be several years in fillng.



Service Pipe Line Company's 154-mile pipe line system in North Dakota.

Few pipe lines are submerged so deeply. Ingenious engineering and meticulous construction methods are necessary for such a project, because once the line is down, it must stay down and must perform its job of transporting crude oil for a great many years without trouble.

Ditching operations on the flood plain of the future reservoir began in August. Historical records of the "Mighty Mo" indicated that the months of August and September are the best months in which to work in the river. Water at that time of year is usually lower and less sediment is moved.

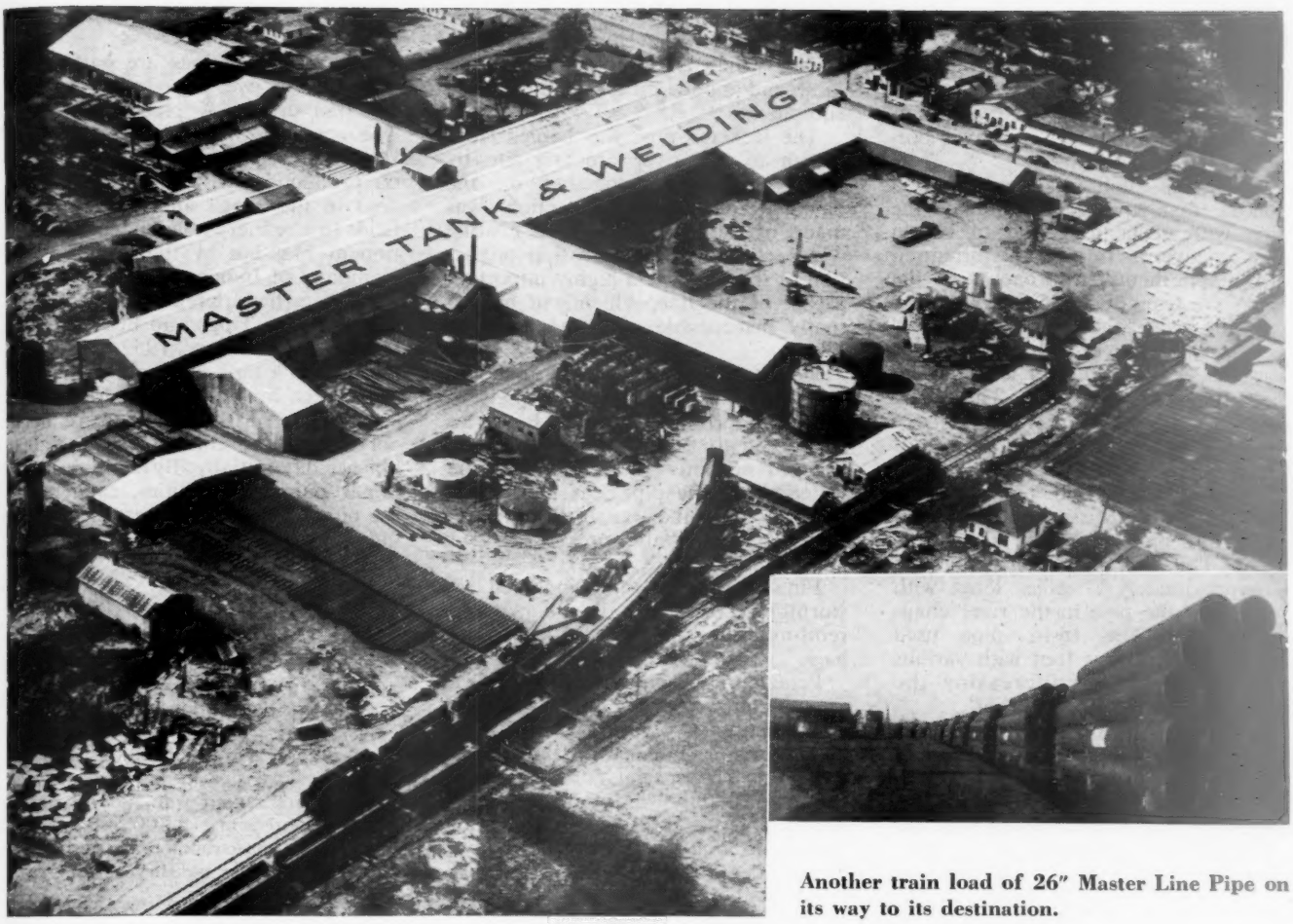
On the flood plain, the line is buried four feet beneath the surface of the soil and laid by conventional methods.

In the river bed, ditching was done by a suction dredge. This tool of

LOOKING south toward the point where waters of the Missouri River, backed up by the Garrison Dam, will cover approximately 2.3 miles of Service Pipe Line Company's new Tioga-Mandan line is Loren Samp, chief inspector for Service. In the distance can be seen the Missouri River, where 1900 ft of line was laid in the channel proper.

AT THIS point the river pipe starts. Picture was taken shortly before river pipe was laid. At rear left can be seen the point from which the photo above was taken.

DOZERS clean and level right-of-way after backfill on the Tioga-Mandan line. Pipe line crews compare this area with West Texas — acres and acres of acres.



Another train load of 26" Master Line Pipe on its way to its destination.

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modern pipelining was disassembled, shipped by rail to the nearest rail point, and hauled to the river piece by piece by trucks. There it was put together and put to work sucking up tons of sand and mud from the river bottom for the trench.

The river ditch was dredged in a manner that would accommodate the pipe without bending and to obtain enough covering to meet the minimum 4-ft requirements. Approaches in the banks are from 30 to 35 ft deep.

In the bed of the reservoir, approximately 2.3 miles of heavy river pipe was laid, with 1900 ft of it in the actual channel of the river. The 12-in. pipe, which has a ½-in. wall thickness, weighs 65.42 lb per foot. Coatings of coal tar enamel and concrete increased the weight another 50 lb per foot.

For the Litle Missouri River crossing, 16-in. pipe was used. The crossing, in Dunn County, North Dakota, is approximately .7 miles long, with 1400 ft of the pipe in the river channel proper. The 16-in. pipe used weighs 82.77 lb per foot with various protective coatings increasing the weight to 172.77 lb per foot.

Pipe used in both crossings was coated at St. Louis, Missouri, prior to being shipped to the job site. A special plant was erected at Sanish, North Dakota, near the river crossing site, for application of a concrete jacket. Tar, glass fiber reinforcement and asbestos felt comprised the original protective coating, followed by the 1-in. concrete jacket, which is reinforced with wire mesh and applied by specially designed equipment.

The jacketed pipe was hauled from Sanish to the river crossing site by truck and welded together on the bank. Radiographic inspection was made of the welds and final coating was performed. The corrosion protection of the line was a highly important aspect of the line, which will be virtually inaccessible after the reservoir fills.

Heavy winches and cables anchored on the opposite bank were used to pull the pipe into the river. Pontoons were used to float the pipe as it was dragged section by section into the water. After the pipe was lowered to the bottom of the trench, the line received a hydrostatic presure test of 1200 psi.

Final part of the job included restoring the disturbed river banks and reinforcing them with rip rap and sand bags.

Pentzien, Inc., of Omaha, Nebraska, as sub-contractor for O. R. Burden Construction Corporation, of Tulsa, Oklahoma, is builder of both river crossings. The special concrete application to the pipe was made at Sanish, North Dakota, by another sub-contractor, Rosson-Richards, of Houston, Texas. The Burden organization has the overall contract for construction of the 154-mile line.

The river crossings are part of the construction work on the Tioga-to-Mandan crude oil pipe line system. The new pipe line, which will be the state's principal outlet for its crude oil production, will transport oil gathered in the Tioga and Beaver Lodge fields to a refinery now under construction at Mandan by the Standard Oil Company of Indiana.

Service has operated a gathering system in the Tioga and Beaver Lodge fields since February, 1952. Oil is now pumped to a tank car loading rack for movement by rail to refineries. With completion of the Mandan refinery, Service will be able to pump 30,000 bbl per day initially. By building additional pumping facilities, capacity of the pipe line can be increased to 100,000 bbl per day. * * *

☆ ☆ ☆

The gas industry now is serving more than 26,000,000 customers, including about 315,000 LP-gas customers. More than 900,000 new customers were added to gas utility line and for the last four years, an average of more than 902,000 customers have been added annually. Customers served with natural gas now aggregate 19,700,000, representing approximately 75 per cent of the total gas industry customers.

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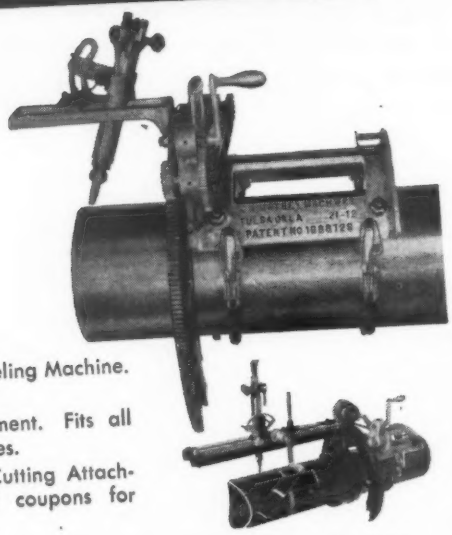

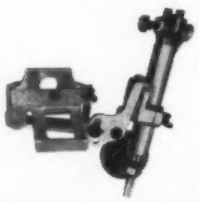

Illustrated above: Mathey Pipe Cutting and Beveling Machine. Cuts pipe at any predetermined angle.
Illustrated left: Mathey Out-of-Round Attachment. Fits all sizes of Mathey (and Mathey-made) Machines.
Illustrated right: Mathey Shape and Coupon Cutting Attachment. For cutting pipe intersections and coupons for welding analysis.

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Efficiencies of Centrifugal Compressors

Three choices are offered (when determining efficiencies), but only one tells the real story; here's a method for finding out

HAROLD WOODHOUSE

It is a common thing these days, in conversations with pipe line operators and engineers, to hear them quote centrifugal compressor efficiencies in the range of 85 to 87 per cent. They are usually indefinite about the type of efficiency they are quoting and often are unconscious of the fact that they could have their choice of at least four different efficiencies: Polytropic, adiabatic, overall adiabatic shaft, and isothermal. Actually, isothermal efficiency is used only with reference to cooled compressors. Other reference to it will be omitted in this article.

Any type of efficiency in the 85 to 87 per cent range for a centrifugal compressor is extremely high. It is feasible only because the inlet velocities are kept very low, in the order of 70 to 80 ft per second, the impeller tip speeds are very conservative, about 380-520 ft per second, and the volume flows are quite large. Change any one of these conditions very much in the wrong direction and any type of efficiency of 85 to 87 per cent becomes an impossibility.

For all uncooled compressors the polytropic efficiency is the one to quote to create the best impression, as it is the highest value. Conversely, the overall adiabatic shaft efficiency is the one not to quote as it is the lowest, and most honest, because it can be used directly to obtain the brake horsepower input required to drive the compressor.

Adiabatic efficiencies of 84 per cent have been obtained at 1000 ft per second with impellers machined from solid forging but these were given 50 to 100 hr of hand-filing and polishing followed by sand or vapor blasting.

Some of the latest pipe line compressors have machined from solid forging impellers with about 100 hr of hand finishing after vane milling. They have the advantage over fabricated designs in that they have no rivet heads or unwanted vane edges opposing the gas stream. It should be easier for this type to reach a high peak of efficiency than those using cast-steel impellers or those that are partly cast and partly fabricated. The surface finish of an impeller in a compressor handling very large volumes of gas, however, may not be the deciding factor in peak efficiency.

The Author

Harold W. Woodhouse is chief engineer of Dean Hill Pump Company, and during this period has acted as consultant for Cooper-Bessemer Corporation in supervising design of a line of pipe line centrifugal compressors.

He was educated in England where he was associated with Fraser and Chalmers Ltd. He later joined in the engineering department of DeLaval Steam Turbine Company, Trenton, New Jersey, and later became engineer in charge of development of the radial flow turbine wheels and mixed flow compressor impellers.

From 1945 to 1947 he was director of engineering for the Stratos division of Fairchild E and A Corporation, becoming general manager and chief engineer of Power Generators Ltd. in 1947. He resigned his position in 1950 to accept his present one.

The following is a presentation of the three efficiencies in common use for uncooled compressors:

Polytropic Efficiency

The term "polytropic" means "all heat" and is used for processes other than isothermal or adiabatic.

For an uncooled compressor the polytropic, hydraulic, and temperature rise efficiencies are the same.

For the case where the initial and final pressures P_1, P_2, specific volumes V_1, V_2, are known, the polytropic exponent of compression N may be determined from:

$$N = \frac{\log\left(P_2/P_1\right)}{\log\left(V_1/V_2\right)} \quad . \quad . \quad (1)$$

EXCLUSIVE

With N known, the polytropic efficiency η_p may be determined from the relationship:

$$\frac{N-1}{N} = \frac{k-1/k}{\eta_p}$$

$$\text{or } \eta_p = \frac{N}{N-1} \times \frac{k}{k-1} \quad . \quad (2)$$

Where:

$$k = C_p/C_v$$

The final temperature, T_2, however, is quite easily obtained from test or normal operation and from the relationship:

$$T_2 = T_1\left(P_2/P_1\right)^M \quad . \quad . \quad (3)$$

Where:

$$M = \frac{N-1}{N} \quad . \quad . \quad . \quad (4)$$

With N determined, equation (2) may be used to find the polytropic efficiency.

Without the necessity for determining the compression exponent N the polytropic efficiency may be determined directly from:

$$\eta_p = \frac{\log_e\left[\left(P_2/P_1\right)^{\frac{k-1}{k}}\right]}{\log_e\left(\frac{T_2}{T_1}\right)} \quad (5)$$

Adiabatic Efficiency

Until recently, before their adaptation to the compression of hydrocarbon gases and natural gases, centrifugal compressors were used mostly for air and perfect diatomic gases. It was, and still is, a common practice for engineers to make their calculations on an adiabatic basis, which permits the use of Mollier diagrams and facilitates the rapid calculation of compressor horsepower requirements.

The adiabatic process is, however, a purely hypothetical operation so far as the uncooled centrifugal is concerned, as it assumes that frictionless compressor is operating in perfectly insulated

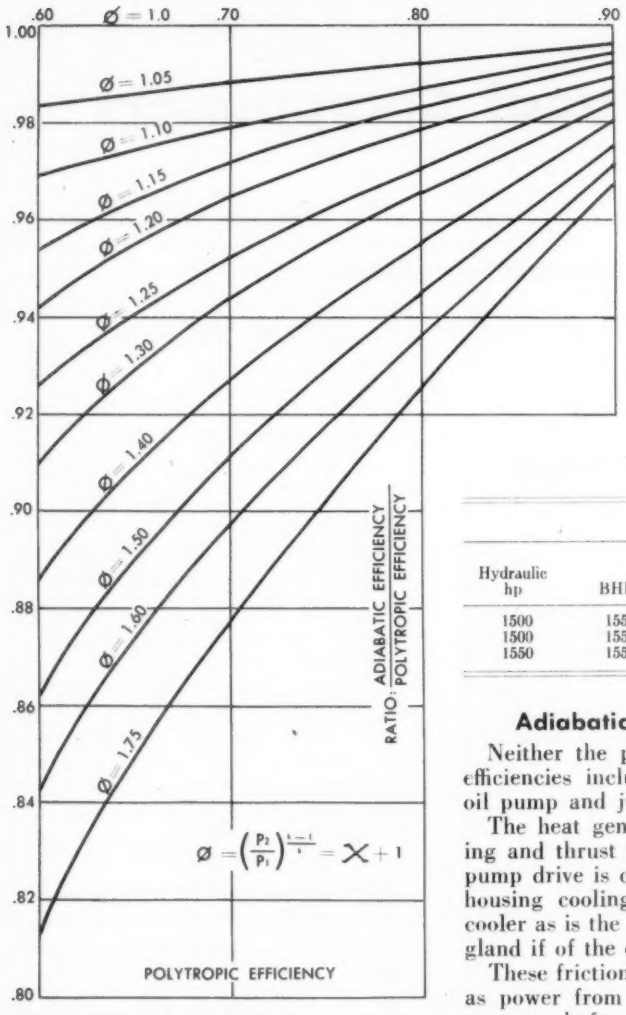

FIG. 1. RELATIONSHIP between adiabatic and polytropic efficiencies.

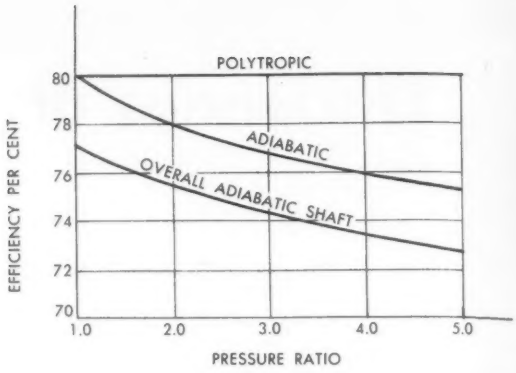

FIG. 2. COMPARATIVE efficiencies of a 1550 BHP centrifugal compressor based on 80 per cent polytropic efficiency.

TABLE 1.

Hydraulic hp	BHP	$\frac{P_2}{P_1}$	Polytropic head	Adiabatic head	Polytropic efficiency	Adiabatic efficiency	Overall adiabatic shaft efficiency
1500	1550	1.3	8,590	8,500	80.0	79.3	76.6
1500	1550	2.8	38,650	37,200	80.0	77.0	74.5
1550	1550	5.0	67,500	63,500	80.0	75.2	72.7

conditions so that there is no transfer of heat to or from the compressor.

For this hypothetical adiabatic compression the theoretical temperature rise:

$$\Delta T_{ad.} = T_{2ad.} - T_1 = T_1 \left[\left(\frac{P_2}{P_1}\right)^{k-1/k} - 1.0\right] = T_1 X \quad (6)$$

Values of

$$\left[\left(\frac{P_2}{P_1}\right)^{k-1/k} - 1.0\right] = X$$

are tabulated in the *Compressed Air Handbook* and other reference books.

The adiabatic efficiency is, then:

$$\eta_{ad.} = \frac{\text{Theoretical Adiabatic Temperature Rise}}{\text{Actual Temperature Rise}} = \frac{\Delta T_{ad.}}{\Delta T_{actual}} = \frac{T_1 X}{T_{2\,actual} - T_1} \quad (7)$$

The relationship between the polytropic or temperature rise efficiency and adiabatic efficiency may be obtained from Fig. (1).

Adiabatic Shaft Efficiency

Neither the polytropic nor adiabatic efficiencies include the packing gland, oil pump and journal bearing losses.

The heat generated by journal bearing and thrust bearing friction and oil pump drive is carried away by bearing housing cooling water or external oil cooler as is the heat loss of the packing gland if of the oil-sealing type.

These friction losses must be supplied as power from the driver at the compressor shaft coupling in addition to the actual gas horsepower required.

Therefore, to determine the actual brake horsepower required at the coupling to drive the compressor, an overall efficiency must be used that will include these losses.

Either these losses are known or estimated in horsepower, or a percentage in efficiency to obtain the overall adiabatic shaft efficiency. For moderately large compressors the percentage of loss deducted would be in the range of 1 to 3 per cent.

The overall adiabatic shaft efficiency will be lowest of the three efficiencies referred to for uncooled compressors.

The relationship between these efficiencies is illustrated by the following tabulated examples and by Fig. (2). It will be noted that the differential increases with pressure ratio as shown in Table 1.

In the preceding examples of a 1500-hp uncooled compressor where 50 hp is allowed for mechanical losses there is seen to be a spread of 7.3 per cent between the polytropic and overall adiabatic shaft efficiencies for a 5.0 pressure ratio.

One can see the importance, therefore, for being specific when quoting an efficiency.

The relationship between the adiabatic and polytropic efficiencies shown by Fig. (2) may be expressed mathematically as:

$$\frac{\eta_{ad.}}{\eta_p} = \frac{\left[\left(\frac{P_2}{P_1}\right)^{k-1/k} - 1.0\right]}{\eta_p\left[\left(\frac{P_2}{P_1}\right)^{\frac{k-1/k}{\eta_p}} - 1.0\right]} = \frac{X}{\eta_p\left[\left(\frac{P_2}{P_1}\right)^{M} - 1.0\right]}. \quad (8)$$

For general industrial use such as refinery and blast furnace multi-stage blowers and compressors, the gas and impeller tip speed velocities are considerably higher and there is not quite the same emphasis on the ultimate efficiency. ★ ★ ★

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Determining the Correct Type of

Thermal Protection for Electric Motors

Used in the Pipe Line Industry

Two basic types of thermal relays are available; Operating safety may depend on correct installation

BRADFORD KLEINMAN

THERMAL protection of motors used in the pipe line industry has been a just cause for concern because explosive atmospheres and other considerations often require that protective relays and their arcing contacts be placed at locations remote from the motors they protect. This separation can mean that relays and motors are subjected to different and varying ambient temperatures. The difference in ambient temperature is the big stumbling block in the proper thermal protection of motors.

In one case, motors may be inside a nicely heated pump room, whereas the switchgear containing the thermal relays is outdoors in freezing rain or snow. Again, protective relays may be on a switchboard in a comfortable control room, and the motors they protect out in the sun when the temperature is 110 F in the shade.

When applying thermal protection, a review of the different types of thermal relays available and a study of their basic principles of operation are often helpful.

Basically, there are two types of thermal relays normally applied to either high voltage switchgear or high capacity motor starters for protection of 200-hp and larger motors operating at rated voltages between 2400 and 15,000. These relay types are (1) the replica types, and (2) the bridge circuit type relay.

Even though there are a great many variations in each of these two types, a general understanding of their operations and of the different features available on each type relay will give us a starting point from which to approach the problem of selecting a relay for a particular installation.

Replica Type Relays

Fig. 1 illustrates a replica type relay. It is nothing more than an element that has thermal characteristics very similar to those of the motor that it is to protect. The replica type relay is simply connected to a current transformer in the circuit motor. It is not connected to the motor itself in any way. The current transformer simply supplies a proportional amount of the motor load-current to the relay. This current produces heat in the relay element. When the relay temperature reaches a predetermined maximum, corresponding to the maximum allowable motor temperature, the relay contacts close.

Generally, a replica type relay consists of a bimetallic strip within a heater element. An increase in temperature causes a twisting motion of the bimetallic strip, and this motion is used to close the relay contacts.

On the basis of its operating principle, we see that in theory the simple replica type relay shown in Fig. 1 can be applied in only two cases:

Where the motor and the relay are always subjected to practically the same ambient temperature, or where the motor and relay are in locations having different ambient temperatures but both temperatures are constant.

If a simple replica type relay is applied for protection of a motor operating in a normal ambient temperature, and the relay is located where the ambient temperature is continually rising, the motor may be tripped off the line at less than full load, as the relay responds to a portion of the load current plus its own element temperature.

Another relay in the replica class is the ambient temperature compensated type. This relay compensates only for differences in temperature around the relay and has no way of telling what the ambient is around the motor. Compensation is accomplished by adding a second bimetallic strip. This second bimetallic strip is not subjected to any heating from the motor current, and is only affected by the ambient temperature. As the second strip is wound opposite to the first, any turning action caused by an ambient temperature change is cancelled, and the relay responds only to changes in motor loading. Theoretically, compensated relays of this type should be applied only when the motor ambient temperature is comparatively constant and the relay itself is subjected to varying ambient temperatures.

Each relay has its own applications. For instance, when it is permissible to locate the relay adjacent to the motor, and both motor and relay operate at the same ambient temperature, the uncompensated relay will give motor insulation closer protection than the compensated relay.

As the ambient temperature compensated relay is affected only by motor load current, "Why not use a simple over-current induction relay, and forget about the thermal type relays?" is a question often asked. The answer is, thermal relays are preformed because they actually have memory. For example, if a motor has been operating at half load for some time, the thermal relay will permit it to carry a slight overload for a period of time. No damage results because a definite period of time is required before motor insulation heats up enough to be damaged. On the other hand, the standard overcurrent relay takes a motor off the line during a momentary overload, no matter what the previous motor loading.

Bridge Circuit Type Relays

Fig. 2 illustrates the bridge type relay in its simplest form. As the drawing indicates, part of the bridge type relay does contact the motor. Usually a 10-ohm temperature detector is embedded

The Author

Bradford M. Kleinman, an application engineer at Allis-Chalmers Boston Works, has been associated with the company since 1949. After receiving his bachelor of science degree in electrical engineering from the New Mexico College of Agriculture and Mechanical Arts in 1948, Kleinman engaged in guided missile work at the U. S. Naval Research Laboratory in Las Cruces, New Mexico, before joining Allis-Chalmers.

EXCLUSIVE

in the windings of the motor and forms one leg of the wheatstone bridge.

A bridge type relay operates just like a wheatstone bridge except that the relay element that actuates the relay contacts is substituted for the milliammeter. Under normal operating conditions, little or no current will flow through the center portion of the bridge, but as soon as the motor begins to heat, the 10-ohm temperature detector will heat up and increase its resistance. This increased resistance causes an unbalance in the bridge circuit and current flows through the center portion of the bridge. As the motor continues to heat, the bridge becomes more and more unbalanced until the current in the center portion of the bridge reaches a predetermined value corresponding to the maximum temperature permitted on the motor. At this point the current causes the relay to close and take the motor off of the line.

Fig. 2 shows that there are four legs to the bridge circuit, one of which is in the motor and three of which could be in the relay. Now, suppose all legs of the bridge are made of the same material and have the same resistance temperature coefficient. Then suppose the temperature around the relay falls. This would cause the resistance of the three legs in the relay to be reduced. As far as the bridge circuit is concerned, this would be the same as a temperature increase in the motor leg, causing an unbalance in the bridge circuit. This could cause the relay to take the motor off of the line when actually there was no overload on the motor.

There are several ways to overcome this. Some relays use a material of zero temperature coefficient for the three legs that are in the relay. In other words, the resistance does not vary with temperature changes, and the relay becomes ambient temperature compensated. The leg of the bridge in the motor does change its resistance with ambient temperature changes around the motor, which is as it should be, because motor heating is due to both load current and ambient temperature.

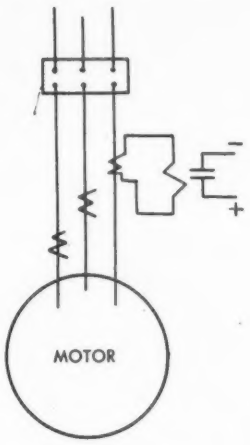


FIG. 1. REPLICA type relay.

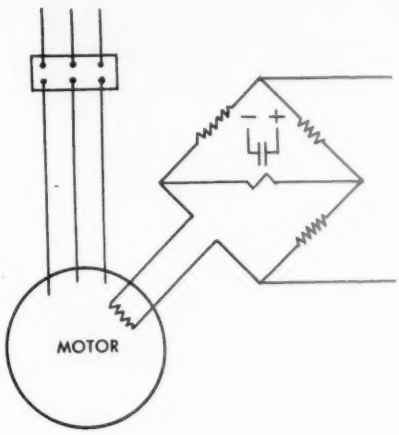


FIG. 2. BRIDGE type relay.

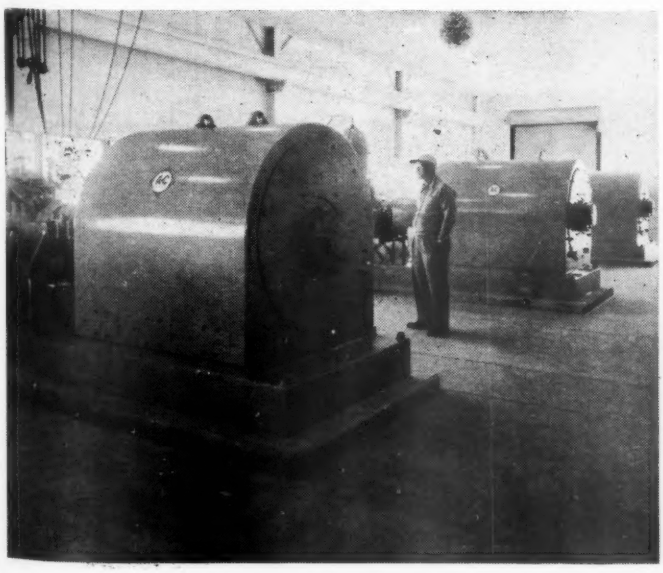
Another type of bridge relay takes care of this problem by placing the three legs, normally in the relay, in a box for separate mounting. This box is then situated adjacent to the motor and in the same ambient temperature. The relay then responds to motor heating due only to load current. To compensate for the difference between the "hot spot" temperature and the detector temperature, the relay legs can be made of a special material having a temperature coefficient approximately one-half that of copper.

Another type thermal protective device combines the bridge type relay with a load current indicating device. An induction type relay is operated by the unbalanced bridge circuit and also by a line current transformer. This relay will not trip on any load current as long as temperature of the motor, as indicated by the bridge circuit, is within safe limits. If the temperature rises above the safe limit and the full load current is also exceeded, the relay contacts will close. In other words, a high motor temperature and an overload must exist before this relay will operate.

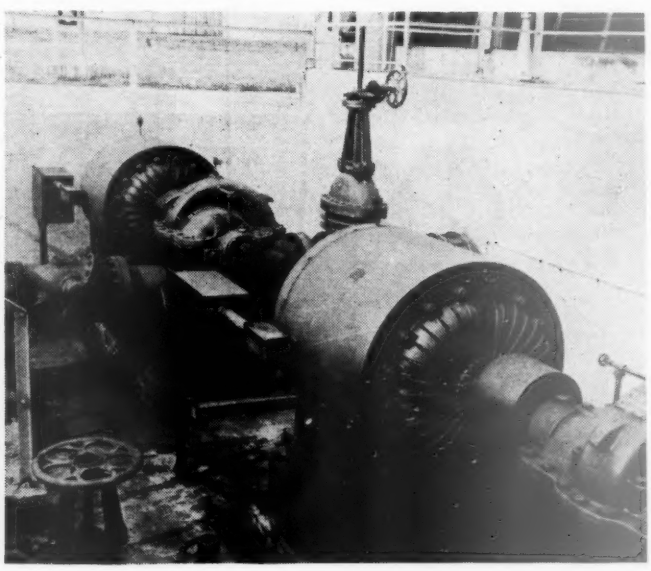
Another thermal protective device of the bridge type is built as a recording instrument. In this instrument any unbalance indication is passed through an electronic amplifying circuit before it operates the tripping contacts. This gives improved accuracy to the instrument.

One of these instruments alone can be used to detect temperatures at as many as 16 points. This is accomplished by a commutator arrangement that auto-

EXAMPLE of indoor installation of motors used in crude oil pumping station service. Selection of proper thermal relays depends largely on location of motors and switchgear. If switchgear for inside motors is outside, special factors must be considered.



CLIMATIC CONDITIONS are a major factor in selecting thermal protective devices. Equipment for this motor and pump unit, located in Mexico, would vary greatly from that needed for a similar installation in the northern part of the United States.



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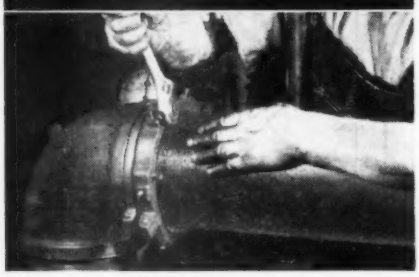

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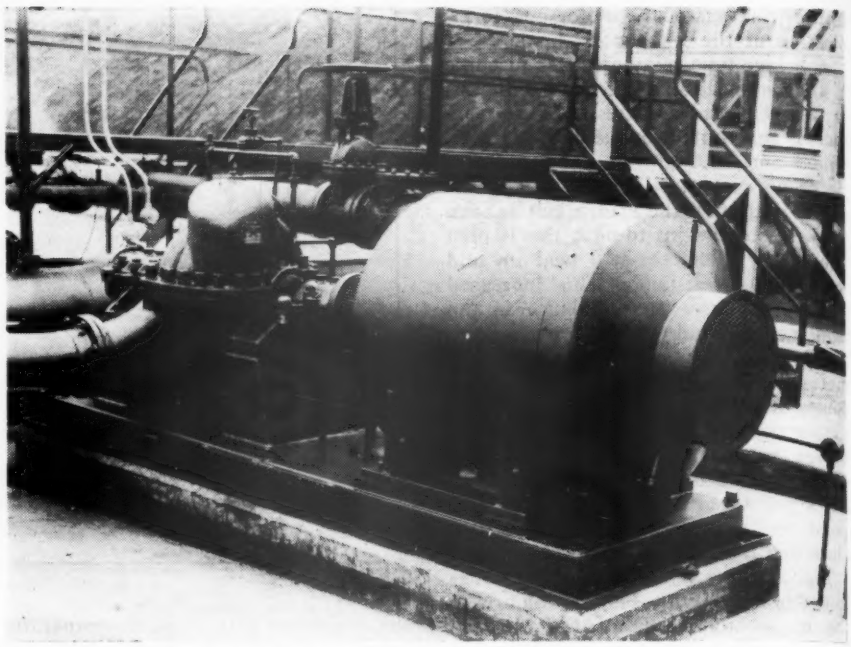


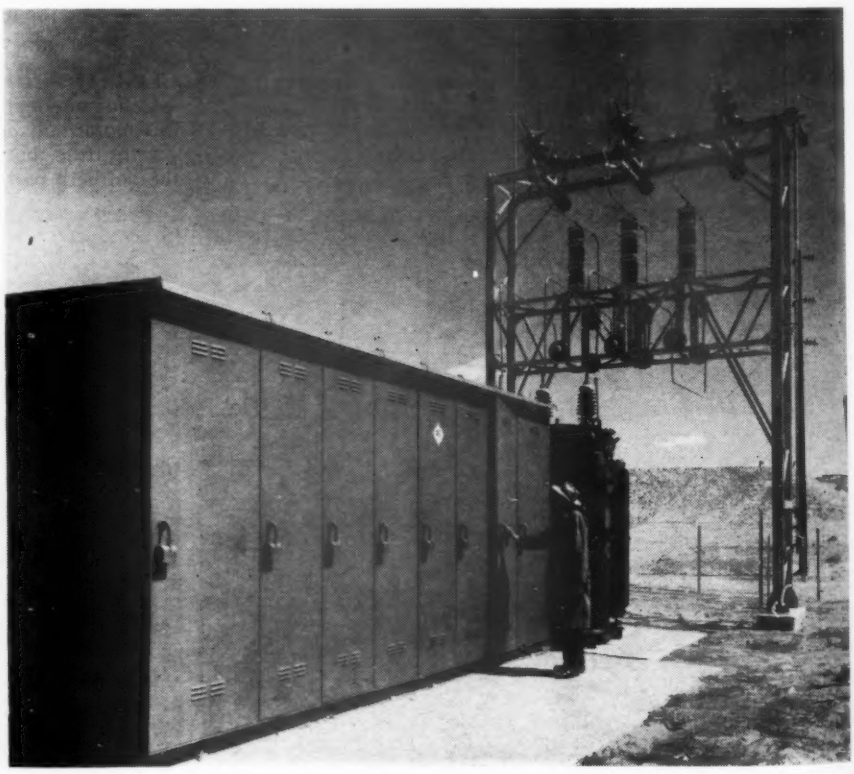
OUTDOOR LOCATION in California, with switchgear nearby, illustrates the widely varying conditions that must be considered in selecting equipment.

matically goes through cycles of checking the individual temperatures at all points. In addition, the temperatures are recorded on a strip chart to give a permanent record of the operation of the machines being protected. These instruments can be provided with multiple contacts so that at a predetermined temperature an alarm may be sounded. If temperature continues to rise, instrument can take motor off the line at the next higher predetermined temperature.

One of these instruments can be used to protect several machines, as the instrument can be provided with separate tripping contacts that operate only the one breaker feeding the individual motor in trouble.

Changes in lead resistance between the relay and the detector element caused by ambient temperature changes affect all bridge type relays. To the relay, these resistance changes are changes in the detector circuit resist-

SWITCHGEAR in outdoor location. Temperature differences between outdoors and indoors affect selection of relays to be used.



ance. For this reason the resistance of these leads should be kept as low as possible. As the resistance of the detector is approximately 10 ohm, then if the lead resistance is kept well below 1 ohm, the lead resistance changes will be only a small fraction of an ohm, and will not normally affect accuracy.

System Performance

If protecting the insulation of a motor is the only problem, at least one of the relays discussed could be selected to give proper protection; however, as the overall performance of the entire system is of equal concern, it may be necessary in some cases to sacrifice adequate thermal protection in order to obtain the required overall system operation.

In providing thermal protection, one thing, and one thing only is being protected—the motor itself. Very elaborate thermal protection will not make the overall system any more reliable, unless it is in a very indirect way, nor will it permit individual motors to operate for longer periods of time without interruption. Actually, the more thermal protection or the more sensitive thermal protection that is used, the more shutdowns a system is going to have. The least little abnormality might be enough to set off a very sensitive thermal device.

Following this line of reasoning many types of installations can be found in which it may be desirable to have no thermal protection at all. This would certainly be true for installations where starting up the process again might cost several times the price of a new motor. In cases such as these, if thermal protection is to be used, the relay probably should actuate an alarm rather than take the motor off the line. The operator could then attempt to correct the situation while the motor was still running. If nothing could be done, but every extra minute that the motor continued to run put an extra dollar in someone's pocket, then the motor could continue to run until it burned out and stopped.

Applying the Proper Relay

When applying thermal protection for a specific installation, it may be necessary to derive the proper protective relay through a process of elimination.

For example, assume an application where it is impossible to mount the thermal relay adjacent to the motor. The motor is in a motor room and the thermal relay has to be mounted outdoors in a switchgear group. As a wide variation in ambient temperature will be encountered around a relay located outdoors, the simple replica type probably would not be satisfactory. If the simple replica type of relay were used, on a cold day the motor could be operating overloaded and the relay would never know it. On the other hand, on a hot day the relay may take the motor off the line when it was not even carrying full load.

The next choice would probably be the ambient temperature compensated

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replica relay. This relay should give satisfactory protection assuming that the temperature of the motor room is fairly constant.

Carrying this case one step further, let us assume that the temperature in the motor room varies considerably during the period of a day. In this case, the compensated relay may not give satisfactory protection. If the room temperature got too high, both ambient temperature and load would heat the motor, but the compensated relay would not detect the high motor temperature because it responds to motor loading only. On the other hand, if the room temperature were to go very low, the relay might take the motor off the line because of only a slight overload. This last condition might or might not be an undesirable operation. An operator might want to overload a machine occasionally if he knows he is not overheating the motor insulation.

As the compensated relay does not seem to give us the required operation under widely varying motor ambient temperature, a bridge circuit type relay with temperature detectors embedded in the windings of the machine should next be considered. This type relay gives a true indication of temperatures in the motor windings, and should give satisfactory protection for the insulation.

To this point we have been selecting relays to provide the best protection for motor insulation. Let us now go back and look at the selections we have made with the idea of compromising between best insulation protection and best operating performance. For instance, we have just concluded that a bridge circuit type relay will give the best insulation protection for an application when both the relays and the motor are subjected to different and varying ambient temperatures.

This type of protection might be very desirable where the continuous operation of the motor is not essential — for instance, a pump motor that is used to pump water into a reservoir and is not required to operate 24 hours each day. In this case it would be permissible to shut down the pump at any time during the day if the motor became overheated by an overload or possibly a high ambient temperature. The operator could permit the motor to cool down or let the ambient temperature come down to normal again, and then make up for his lost pumping time.

If the motor it protects is required to operate continuously the bridge circuit type relay might be undesirable because it will shut down the motor even if the only trouble is a slightly high ambient temperature. If operation of this motor were critical enough, it might dictate the use of a compensated replica relay that will respond to motor loading only, and will ride through these temporary conditions of high motor ambient temperature. In this case the loss of insulation life due to overheating has to be justified against the continuity of operation procured.

Another possibility is a relay combining the operations of the replica type relay and the bridge circuit relay. This relay, you will recall, operated both from a temperature indication of the windings and also the actual motor load current. Before this relay will operate, the motor must carry an overload while the windings are overheated.

This relay has one desirable feature not found in the compensated replica type relay. It will permit the motor to carry an overload as long as the windings are not overheated.

☆ ☆ ☆

On the average, during 1952, nearly 306,000,000,000 gallons of petroleum and petroleum products were delivered to American consumers every day—by pipe line, water, rail and truck.

Conclusions

From these examples it can be concluded that:

1. There is an ample selection of thermal relays available for most any application.
2. The effect of ambient temperatures should be given more consideration in selecting proper thermal relays.
3. The function of the particular motor should be given serious consideration in selecting the type of thermal protection. ★ ★ ★

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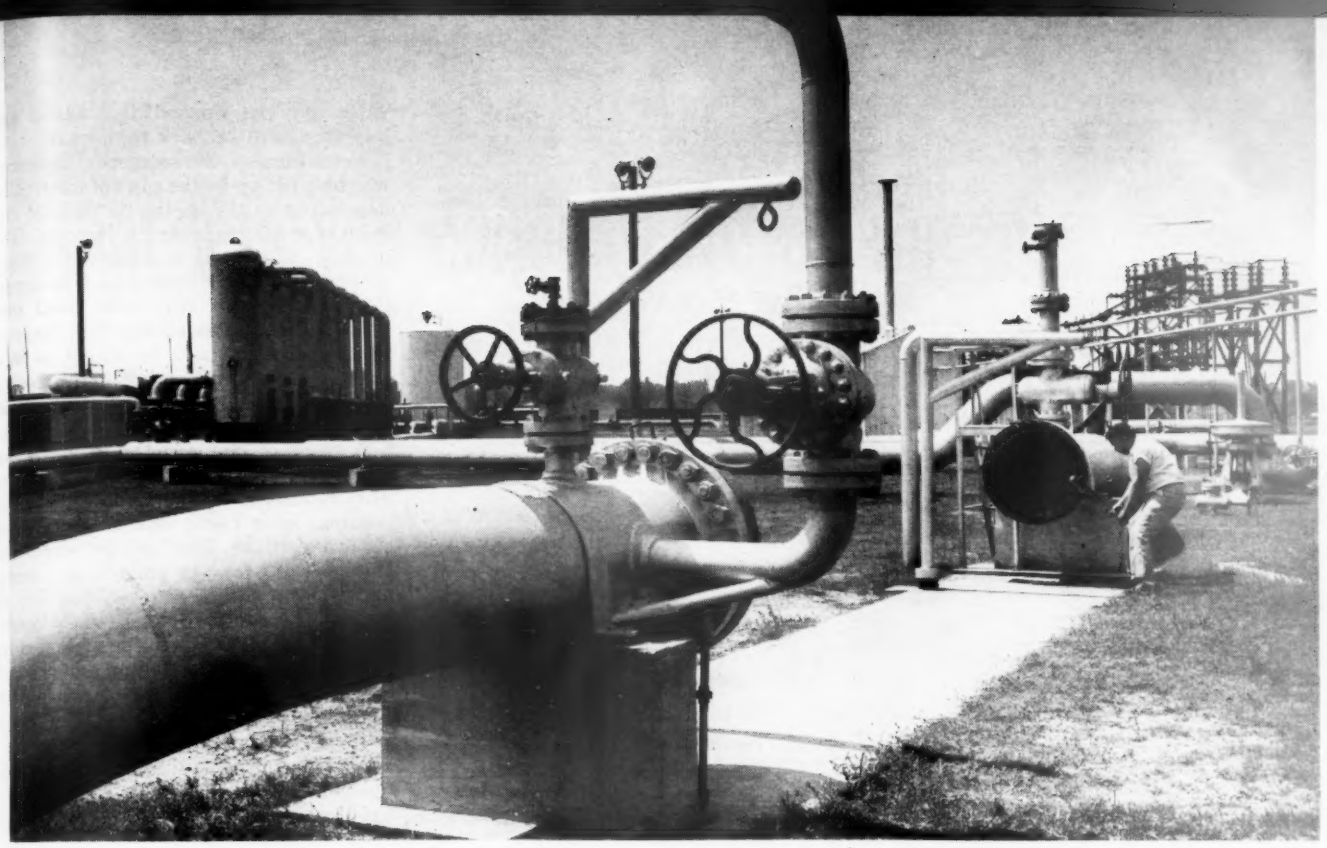


PIG TRAP installations at North Little Rock, Arkansas, compressor station on Texas Eastern line.

P 625.4

Economical, Efficient

Cleaning Gas Lines Internally During Operation†

Improved efficiency of transmission, continued operation possible by use of scrapers on natural gas pipe lines developed by the Texas Eastern Transmission Corporation

E. T. ROBINSON, JR.*

It is realized by all planning and design engineers that the optimum system would be one operating at peak deliveries the year around. A few of the companies with the proper facilities are operating at full-load factors the full year, and a number more are providing the facilities as fast as they can be developed. Regardless of the facilities available, it is the maintenance of equipment, the per cent of "on the line" time that produces the 100 per cent load factors.

Companies have gone to great expense at their compressor station to provide standby or oversized equipment so that the running equipment may be maintained without cutting down on the throughput at the station—but how many have provided facilities for maintaining the insides of their pipe lines so that the throughput will not be cut down? This is like changing the oil and overhauling your car motor but letting the tires wear out, which, after all, carry the load.

The only way that the pipe line can be maintained, excluding the surface maintenance which does not contribute to the throughput, is by internal cleaning or scraper running. There are several approaches to this, and scraper running is nothing new to some phases of the industry. The oil companies long ago realized the necessities and have been very successful in the internal maintenance of their line, both on and off stream. The only phase that is new is the internal cleaning of a gas line while in operation.

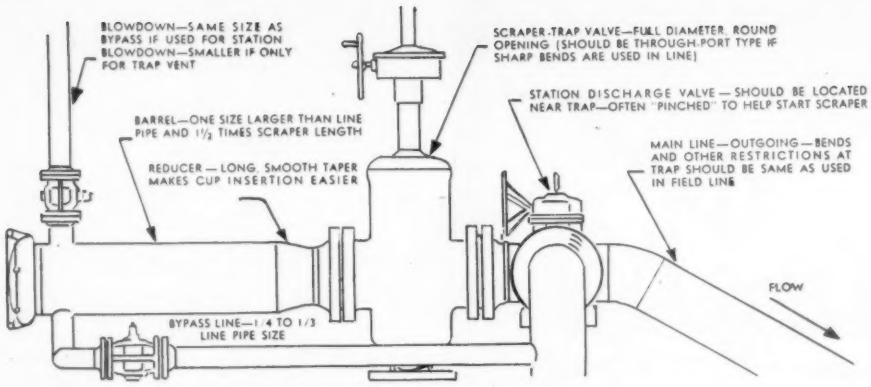
Texas Eastern's Case

Texas Eastern acquired the War Emergency Pipelines for conversion to natural gas, which had been in crude oil and products service during World War II. A line efficiency, much less than that normally used for new construction, was assumed for the design of the pumping equipment for the initial load. After making a first flow test in 1947, it was found that the line efficiency was 67 per cent, which was a great deal lower than had been anticipated. This made it necessary to launch some type of cleaning program.

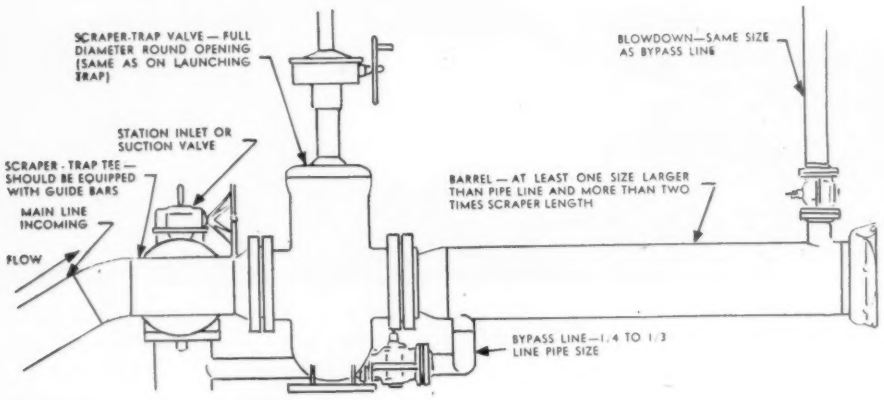
The first efforts were along conventional procedures of syphoning liquids and blowing section. Next consideration was given to taking a section of line out of service and running scrapers to atmosphere. Cost was calculated that with the curtailment produced by the line being out of service and with gas loss involved by blowing to atmosphere, the expense of such a project would run into an astronomical figure since 2800

†Presented at the gas technology short course, Texas College of Arts and Industries.

*Texas Eastern Transmission Corporation, Lebanon, Tennessee.


BLOWDOWN—SAME SIZE AS BYPASS IF USED FOR STATION BLOWDOWN—SMALLER IF ONLY FOR TRAP VENT
SCRAPER-TRAP VALVE—FULL DIAMETER ROUND OPENING (SHOULD BE THROUGH-PORT TYPE IF SHARP BENDS ARE USED IN LINE)
STATION DISCHARGE VALVE — SHOULD BE LOCATED NEAR TRAP—OFTEN "PINCHED" TO HELP START SCRAPER
BARREL—ONE SIZE LARGER THAN LINE PIPE AND 1½ TIMES SCRAPER LENGTH
REDUCER — LONG, SMOOTH TAPER MAKES CUP INSERTION EASIER
MAIN LINE—OUTGOING—BENDS AND OTHER RESTRICTIONS AT TRAP SHOULD BE SAME AS USED IN FIELD LINE
FLOW
BYPASS LINE—1/4 TO 1/3 LINE PIPE SIZE

TYPICAL launching trap for scrapers.


SCRAPER-TRAP VALVE — FULL DIAMETER ROUND OPENING (SAME AS ON LAUNCHING TRAP)
BLOWDOWN—SAME SIZE AS BYPASS LINE
STATION INLET OR SUCTION VALVE
SCRAPER - TRAP TEE — SHOULD BE EQUIPPED WITH GUIDE BARS
BARREL — AT LEAST ONE SIZE LARGER THAN PIPE LINE AND MORE THAN TWO TIMES SCRAPER LENGTH
MAIN LINE INCOMING
FLOW
BYPASS LINE—1/4 TO 1/3 LINE PIPE SIZE

TYPICAL receiving trap for scrapers.

miles of line required this type of maintenance.

The launching and running facilities for handling scrapers were available at each station and had been used when the lines were in crude and product service. After many consultations on the pro and con of such a venture, it was decided to try a scraper in the stream similar to the methods used by the oil companies.

This first experimental scraper was run in the 24-in. line during May, 1948, for a distance of 50 miles and was completed successfully. After a second experimental run in the same month in another section of the 24-in. line, it was found that the efficiency was raised from 72 to 81 per cent, which proved the real economy of this type of cleaning. Subsequent tests were made in the following month to compare the gain in efficiency produced by running to atmosphere against running in the stream.

For all practical purposes the results were equal. The economy of running in the stream far outweighed the running to atmosphere by the fact that curtailment of deliveries were not produced by portions of the line being out of service, and large volumes of gas were not wasted by blowing to atmosphere.

All of the blowing, syphoning of liquids, installing of drips, and other conventional methods of cleaning, up to this time, June, 1948, had only produced an efficiency of 73 per cent, which was 14.5 per cent less than that required to handle the design load. An intensified cleaning program was started and the result was a weighted efficiency of 92 per cent plus for the system by the end of 1949. This was done without any curtailment of deliveries and less gas loss than might be consumed in cleaning one section during a summer shut-down program.

Different Situation

Texas Eastern's situation was different from lines built previously for gas service; as mentioned before the facilities were available for running and receiving pigs, and with only a few modifications, the company was able to adapt them for gas. The running procedure is fairly simple.

Essentially the traps are a short extension of the suction and discharge lines with a valve and barrel assembly. The scrapers are loaded in the barrel and then the pressure in the trap is equalized with the line. The trap valve is then opened and differential is built up by pinching the discharge valve, allowing the pressure in yard piping to increase while the line is decreasing. As the yard pressure is turned in behind the scraper, it moves into the stream, passing the discharge tie-in point where the gas is feeding in at a reduced pressure.

The required differential ranges from 10 to 50 lb depending on piping arrangement and type of scraper; but to be on the safe side, at least a differential of 35 to 40 lb should be built up before an attempt is made to "kick" the scraper and should be held until the discharge tie-in is passed. After this, the discharge valve may be opened full again and operation will be back to normal.

From then on, the required differential will be built up by the pig automatically, depending on the friction in the line and load that the scraper is shoving. The normal differential to keep the scraper moving will range from 2 to 5 lb across the rubbers, and any static head produced by a column of liquid or body of foreign material will be added to this.

Scrapers do not move continuously but stop for short intervals in tight places in the line long enough for the line back of the scraper to build up pressure to start the movement again. This is only 5 to 10 lb at the kicking point in most cases, unless there is an abnormal tight line or an excessive amount of foreign materials being moved. A pressure gage on the line at the kicking point will show these conditions. As long as the movement is steady, there will be no fluctuation; but when the movement is stopped, the pressure gage will rise until the scraper starts—then the gage will fall or hold steady, depending on capacity of the pumping equipment.

Scraper Movements

Velocity of the scraper will be approximately the normal velocity of the gas stream, and time between stations can be calculated within a few minutes by determining the amount of gas in the section to be run and how long will be required to displace this amount with the input rate being pumped at the station the run is being made from. With the proper piping, the scraper can be brought into the recovery trap unattended; but for a new operation or until crews are familiar with the procedure, the pig should be tracked to check progress and velocity.

Movement within the line is audible and may be checked by placing the ear against road vent, main line valves, purchase or sale taps, or even on the ground at places where the cover is shallow. It may be advisable during this procedure to keep a chart on the mileage and time of passing at each location in order to estimate more closely the time of arrival.

When running in single line, purchase and sale points are cut off to prevent foreign materials from being shoved into customer line for short intervals of 5 or 10 minutes before arrival of the scraper and turned back on 5 minutes after passing. The cut-off on the single line is made by prearranged signal from a person ¼ to ½-mile upstream of the tap, advising a party at the tap when the scraper has passed him. Where multiple lines are installed, the purchase or sales may be switched to one of the other lines while a section is being run.

The receiving procedure is similar to the kicking, except here the suction valve is pinched, allowing the line pressure to build up. The incoming gate on the trap was opened when the scraper was started from the upstream terminal; and as it arrives at the downstream station, it can be heard by the receiving personnel and will stop between the station suction tie-in and the scraper

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HD-20

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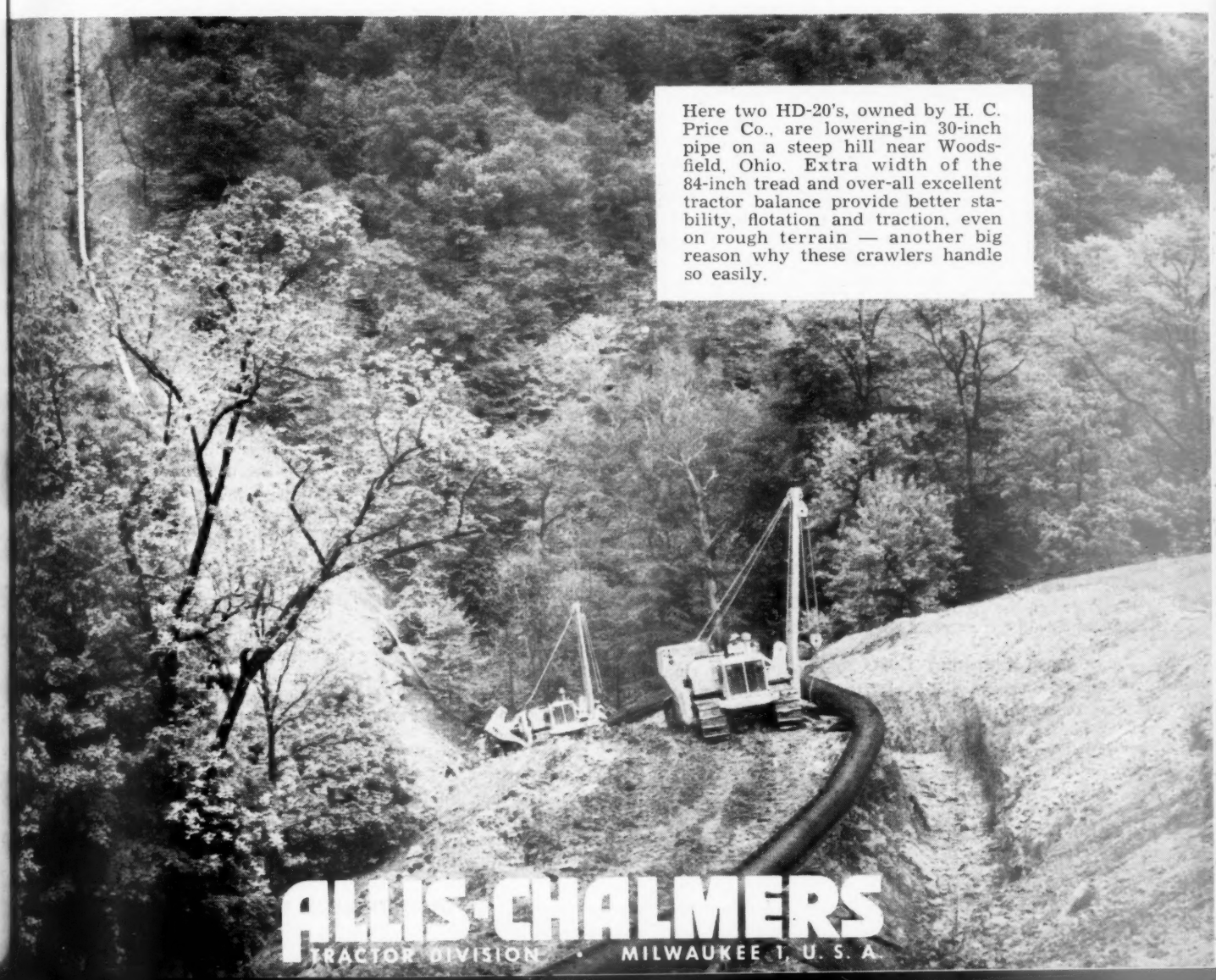
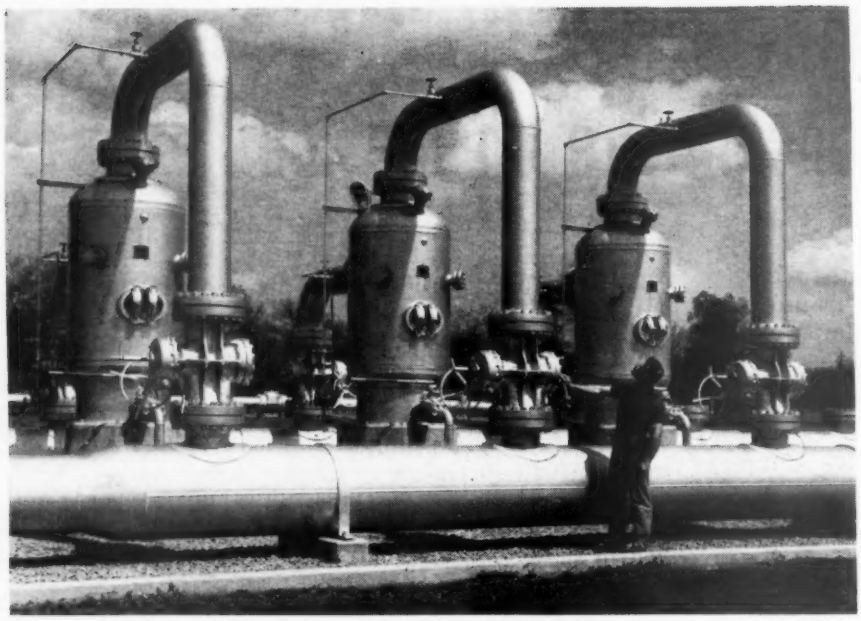
Bare Tractor — 41,000 lb.
175 net engine hp.



Here two HD-20's, owned by H. C. Price Co., are lowering-in 30-inch pipe on a steep hill near Woodsfield, Ohio. Extra width of the 84-inch tread and over-all excellent tractor balance provide better stability, flotation and traction, even on rough terrain — another big reason why these crawlers handle so easily.



SCRUBBERS recover lighter foreign materials that collect in natural gas lines. This installation is on Texas Eastern's line from Kosciusko, Mississippi, to Connellsville, Pennsylvania.

gate. Blow-offs opened on the barrel will allow the scraper to pass through the valve into the trap, after which the gate is closed and the scraper removed. The majority of the lighter foreign material will be recovered in the scrubbers with the remaining being blown out when the blow-offs are opened or removed from the trap with scraper.

The procedure would apply to a system that is cleaned periodically, and different measures should be taken for a system that has had no prior cleaning or on a new system being cleaned for the first time after putting into service following line test, particularly, if it is suspected that more liquids and foreign materials will be recovered than the scrubber can adequately handle. It is recommended under these conditions that the station be shut down and the line blocked at the receiving location and that the scraper be brought in with the blow-offs, unloading anything ahead of it to atmosphere, rather than filling the yard piping.

A person may be located ½ to 1 mile upstream from the receiving station to notify personnel when the scraper passed. At this time, the station should be shut down and blow-offs opened. By this method, the gas in the last half mile or so of pipe outside the station will be lost; but it is good insurance that yard piping will not fill up and burst a few cylinders when the compressors take on a load of liquid.

Internal Cleaning Costs

All of the cleaning done prior to the running of scrapers raised efficiency to only 73 per cent, a figure much less than required to handle the contract load. It had already been determined that cleaning in the stream would produce the same efficiency as cleaning to atmosphere. But how about the cost? A number of scrapers were run to atmosphere by cutting up the line and costs were recorded to compare with internal cleaning. The average cost per mile for atmosphere cleaning, excluding gas loss and curtailment, was $91.42 per mile. This is a most conservative figure, and other companies have reported costs from $200 to $800 per mile. Seventy-two thousand additional miles were run in the stream to gain an efficiency of 92 per cent at cost of $1.75 to $2.25, depending on line size, per mile. Quite a difference considering no curtailment and a relatively small loss of gas. Recent runs in 30-in. line indicate a cost of approximately $3 per mile. In considering these costs per mile for "in stream" running, it must be kept in mind that all labor and transportation used in deriving the figures are fixed operating cost. The only additional out-of-pocket money is the replacement parts for scraper, which will reduce the actual additional expense to a figure much less than $1.00 per mile.

Losses and Efficiency

Few companies can afford to raise line pressures to overcome loss efficiency because of design code limitation as most lines are designed to operate at maximum pressure on the initial load. The fact may be pointed out that the station can be overloaded 10 per cent to make up the loss, but this is not economical when you reason that if the line was clean, the extra 10 per cent would be available to handle additional volumes during peak deliveries; and if you are going to figure on continuous overload operation, the line size could have been reduced on initial construction for the same load.

There is one other alternative to regain the loss—that is to add loop line. Two and one-half miles of loop line of the same diameter per 100 miles is required to overcome a decline in efficiency of 1 per cent. At a conservative figure of $60,000 per mile for construction, a large amount of money must be spent on this method to overcome the reduction in efficiency. In Texas Eastern's case, the loops to obtain the desired throughput would have cost $17,000,000 plus. The cost for internal cleaning to obtain the same figure was approximately $157,000. Thus the use of scrapers has afforded a considerable savings and, at the same time, has allowed the lines to be operated at a 100 per cent load factor with a minimum amount of horsepower expended.

Justification of Scrapers

It may be said that Texas Eastern's system does not represent a typical gas pipe line system since it was not designed strictly for gas and had been used in a different type of service prior to the time it was converted to gas. Since part of the facilities were already available, let us consider a new system. The addition of scraper trap and facilities for handling scrapers will increase construction cost of the project by approximately ½ to 1 per cent, which is not a total loss because earning will be figured on this additional investment. This increased cost represents a fair amount of money; and the first thing the board of directors will want to know is—Is this expenditure justified?

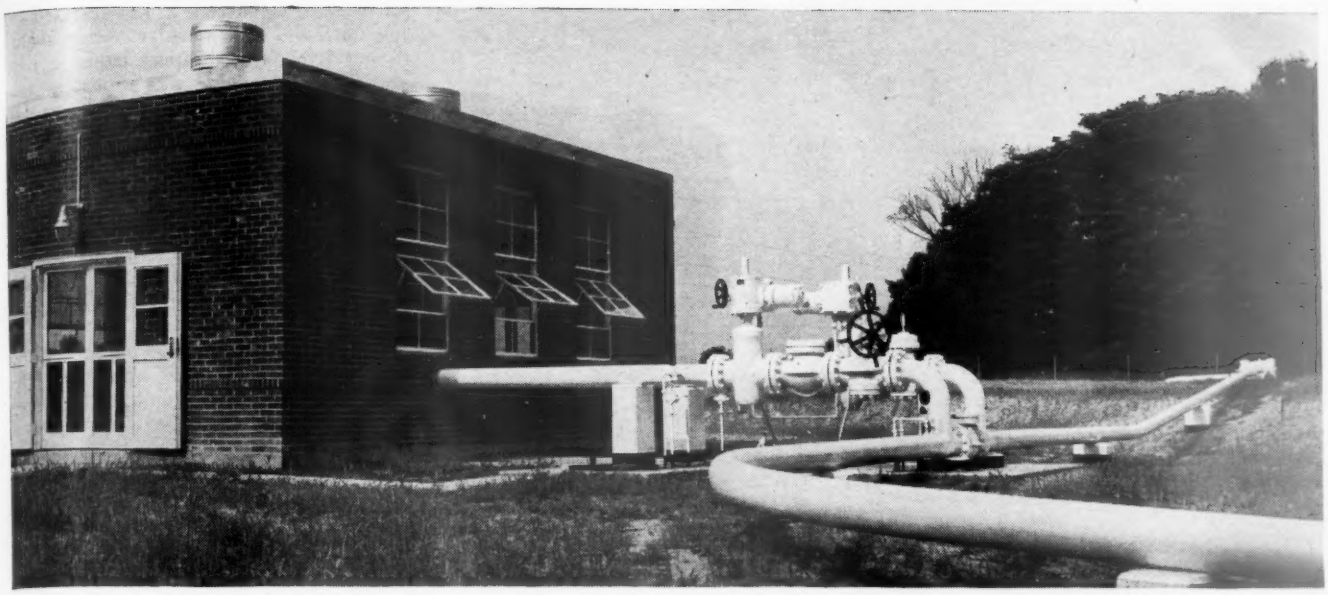
First, deduct from the cost of the system all money estimated for the cost of drips, syphon lines, and other methods of removing foreign material, except the scrubbers at the compressor station. With the use of the scraper, no liquid or dust recovery apparatus is needed, except at the receiving points.

Next, past experience on new lines has shown that at least a 5 per cent drop will occur within the first 5 years of operation; and if the quality of the gas is rich, allowing hydrocarbons to fall out in the line, the drop may come much sooner and even show more reduction. Several companies have reported that their reduction ranged from 10 to 18 per cent in less time. The 5 per cent at the best is a pretty conservative figure. If the line was not cleaned sufficiently after construction, it may show a drop of several percentage points directly after being placed in service.

Assume the addition of extra horsepower into the design, if the line efficiency falls 5 per cent and the same volume is maintained, 10 to 12 per cent increase in power at the pump station will be required.

It is an old story that the less power required to handle a thousand feet of gas—the more the profit, so little can be expected from this increased power. At the same time, nothing is left to take care of maintenance trouble and peak-load demands that normally could be handled by overloading the station for a short duration. Continuous overloading is sure to increase maintenance cost. "How much" would be debatable and could only be judged by each company's own circumstance, but it is something to be considered.

If the power is allowed to stay the



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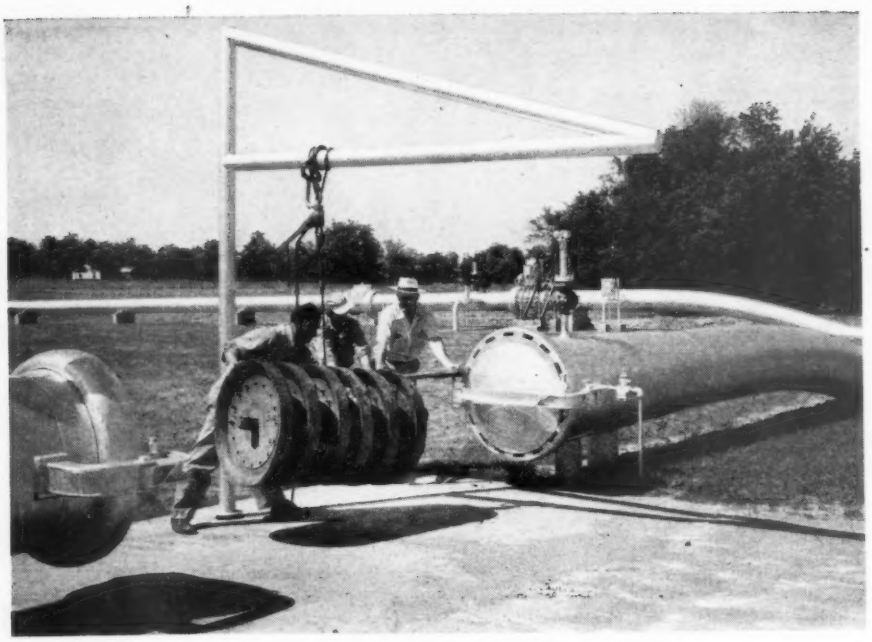

A 30-INCH swab type pig being inserted into launching trap. Pig trap barrels are oversize to allow ease of insertion of pig.

same as design, the 5 per cent drop in efficiency would produce a cut in volume throughput of 2½ to 3 per cent. It can be said without argument that this is a definite loss of revenue.

Companies that have multiple lines say, "We will shut down next summer and clean it up." That is possible, but taking past figures on atmospheric cleaning, more money is going to be spent on one cleaning job, including labor and gas blown to air, than traps would have cost, even if cross-overs are available and the system can be sectionalized so as to prevent curtailment. That company with the single line is stuck.

Maintenance Reduced

Scrapers are not only good for maintaining the inside of a pipe line but are also useful in reducing the maintenance cost of a compressor station. During construction a certain amount of foreign material is left in the line regardless of how careful inspectors may be. Mill scale is something that has to wear out. The makers of scrubbers are doing a good job, but they haven't produced one that will clean perfectly and invariably some of that grit gets to the compressors.

Texas Eastern has a good example of what can be done along these lines. It receives large quantities of gas from two supplies at widely separated points on the system at the suction of a compressor station. Both lines are new. One was equipped with scraper traps and the other was not. Quantities of grit and dust were received with the first deliveries of gas at each location resulting in considerable damage to the compressors.

The line without the facilities for internal cleaning did not clear up for over 14 months after initial deliveries and the supplier went so far as to add cleaning equipment on the section at our station at his expense. The results were that before the line cleaned up it was necessary to completely overhaul the compressor end of six engines 3 times within a year, replacing rod, piston, and cylinder lines. This is expensive maintenance and can tear a station's operating budget to pieces.

After running a few scrapers in the other supplier line equipped for such, the company was able to clear up the condition at the other location within a 10-day period and had to replace only the initial set of rods, piston, and lines at this station.

The additional money spent at the first station would have installed several traps. It can be assumed that the supplier was having the same trouble at his station down the line.

Removing Freeze-Ups

Scrapers have proved to be a valuable asset for cleaning lines where freeze-ups have occurred. Lines in the system up to 26-in. in diameter have frozen off during winter operations. During the past winter, one 20-in. line froze off 3 consecutive times before the condition was finally cleared out. Operating systems with gas having a high hydrocarbon content know the trouble that freeze-offs can cause. It is not recommended that efforts to remove a solid block of ice be attempted with a scraper because as the ice is stacked up, the condition will probably get worse. After the block is located and removed by alcohol or some other method so that the flow is restored, the scraper may be used to remove the moisture, which is probably causing the freeze-off.

The line that froze off three times this past winter was finally cleaned out with pigs. The first block was removed with alcohol. A few days later a second freeze occurred; and after restoring the flow, several scrapers were run. When the third freeze occurred, it was decided to run until the line was dry. After about twenty trips, the scrapers came in dry and no more trouble was reported.

Freezing can usually be forecast by observing the amount of liquid being collected at compressor stations and sales points. When it is suspected that quantities of distillate are being dropped out of the stream, the cleaning should be started so that the line can be cleaned before trouble starts. A drop in efficiency may also indicate the presence of liquids in the line.

On one 50-mile section on the northern end of the system approximately 1000 bbl of liquid was removed by cleaning, preventing freeze-up at delivery points and in the line. On the southern end of the system in sections of lines where gas was delivered through only separators at the well, we removed over 2000 bbl which had collected in less than a year. All together this would have filled a mile of pipe solid had it been in one column. Being able to perform this type of preventive maintenance may be well worth the cost of providing facilities on some systems.

Purging is simplified by use of scrapers and no gas is lost. When new sections are put into service, a pig is inserted and when received at the other end, the line is ready for packing without losing a foot of gas. Intermediate sections between stations cannot always be purged with scrapers if the trouble is at a location other than a valve. If the trouble is a valve, the pig may be inserted when the repair is made, run to the next valve and after the section is equalized and all valves open, the scraper will come into the down-stream station with the stream in the usual manner. Thousands of feet of gas are saved by purging in this manner and eliminates any possibility of having air pockets.

Hydrostatic Testing

Companies have had line breaks which have given a great deal of publicity to safety codes for operation. Opinions have been made and written into some codes requiring line test well above the minimum requirements now used. To prevent further adverse publicity, many companies are finding it necessary to turn to a hydrostatic test because, if a line breaks, the water does not create nearly as great a spectacle as the gas, and also it is much simpler to obtain the desired pressure with the fluid.

Many engineers are satisfied that the water gives a more thorough test, and there is no doubt that a more positive leak test can be made with fluid than gas. Water, in addition to giving the best test, conditions the inside of pipe because the water has a tendency to loosen mill scale, rust, dirt and other foreign material, which are easily removed with the water when the cleaning is started.

Some companies have steered clear of this method of testing because of the enormous cleaning job required. Great volumes of gas can be wasted during cleaning if the proper facilities are not available. With scrapers the job can

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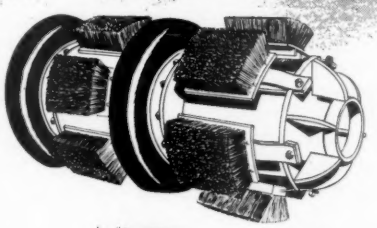

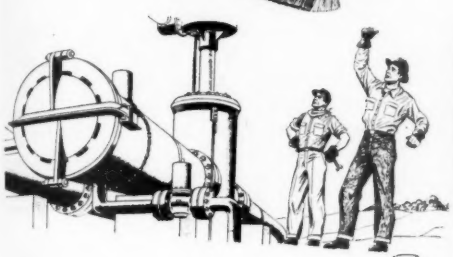

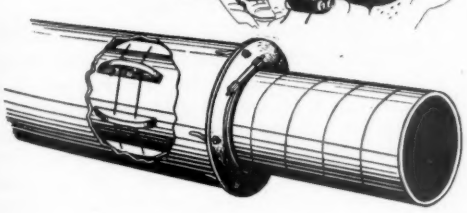

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be done with no more gas loss than would normally be used for blowing and purging a line before testing with gas. It is generally acknowledged that although blowing has been used for years, it is the most inefficient and poorest method of cleaning.

Cleaning Procedure

When testing with water, the line is sectionalized according to the hydrostatic head to prevent overstressing the lowest sections. In most cases the sections can be manifolded adjacent to block valves to that when cleaning, the valve is used similar to a scraper gate at a pump station described previously. That is, the pig is run through the gate and received in the same manifold previously used for sectionalizing, filling and testing. After the scraper is received, the gate is closed, retaining all of the gas used in the run. The scraper is removed when the manifold is cut out.

Before installing the pup joint replacing the manifold, scrapers are loaded for the run in the next section; and after the line pipe is inserted, the cleaning of the next section is started by opening the valve that was closed when the scraper arrived. It may not be possible to sectionalize the line in every case at a valve, but by proper engineering, cleaning of this type can be accomplished with a minimum amount of gas. Sections emptied and cleaned into compressor station, of course, use the same facilities installed for regular cleaning once the system is put into service.

Gas carried ahead may become saturated to a point that it is advisable to blow down and repack some of the sections before proceeding with the cleaning but here again proper engineering, based on the weather conditions and specifications in sale contracts, will hold this type of waste to as small a quantity as possible.

Necessary Conditions

In discussing this type of cleaning, it is necessary to rely on the fact that the desired results may be obtained with one pass of the scrapers. Good results have been obtained with one-pass cleaning under proper conditions. The conditions being: First, that gas be available at a pressure of at least 100 lb in excess of the highest pressure at the pump required to fill the section for testing; second, that at least two or three all-rubber scrapers be run simultaneously; and third, that the sections to be cleaned do not exceed 30 miles in length. Here the shorter the section is the better the results will be.

In general, the scraper should be run at nearly a uniform rate as possible of 3 to 6 miles per hour. Facilities should be available at the receiving end to handle the pig without tearing them up in the trap. Rubbers should be changed when wear reaches a point where an effective seal cannot be maintained. Our experience indicates that the rubber's wear will reduce the diameter of the cup $\frac{1}{8}$ in. per 15 miles of travel on the larger scraper, decreasing somewhat on smaller ones as the weight of unit itself is reduced. The wear is not progressive, and the greatest wear will be experienced during the first 50 miles of travel. As the outside diameter of the cup approaches the inside diameter of the pipe, the rate of wear is reduced. Companies anitcipating hydrostatic testing may save enough on their gas cleaning alone to bear a good portion of the cost of installing facilities.

After Operations

This discussion has attempted to point out the many advantages of internal cleaning facilities and assist in appraising the situation from an economic angle to see if the cost is justified. From a dollar value standpoint, experience has proved that you cannot spend less for value received.

It is not necessary to run the entire system each time a cleaning program is begun. Periodic checks should be made on the efficiency of each section used; as the sections begin to fall off, clean only those that drop below the level you desire to maintain. The cost of running can be weighed against the drop to determine the economics of cleaning, unless freeze-ups or dust are giving trouble. In most cases the purchase end of the system will require the most cleaning, followed by the section subject to the greatest change in ground temperatures. In our situation, 51 per cent of the scrapers have been run in the first 30 to 35 per cent of the system.

As mentioned before, wear determines how far to run pigs. In the large lines (26-in. and 30-in.), using scrapers that the weight is carried on the cups entirely, about 70 to 80 miles would be the limit of an effective run. Scrapers of the same type in lines smaller than 26-in. could be run from 100 to 150 miles with good results. Scrapers with expanding brushes that carry a portion of the weight of the pig may be run effectively from 100 to 350 miles in any size line, depending on the internal condition of the pipe.

FPC Okays 5000 Gas Line Miles

In the first six months of this year, the FPC has authorized construction of new natural gas pipelines that will deliver an additional 2.25 billion cu ft daily to consumers.

FPC Chairman Jerome K. Kuykendall said the authorizations call for construction of 4891 additional miles of pipe line at an estimated cost of $548,982,510.

He said the bulk of the new authorizations were for facilities to serve 69 cities of 50,000 population or more in 19 states and the District of Columbia. He said the new approvals bring to 7123 miles the total new pipe line construction authorized during the 12-month period ending June 30.

The largest single authorization during the first half of 1953 was a $175,250,000 project.

Combinations to run scrapers in depends largely on how well you are attempting to condition the inside of the line. Best results can be expected by first using an expanding brush-type scraper, of which there are several different types on the market, following with a swab-type scraper having more cups. Most expanding brush scrapers only have two cups, one front and one rear.

Runs and Efficiency

How many to run in each section can be determined by checking the efficiency after each run to see if the desired gain has been made or by running until there is no further recovery of foreign material. The first 18 per cent of the total number of scrapers Texas Eastern ran in bringing the line efficiency to 92 per cent produced over a 10 per cent increase. The next 50 per cent only produced a four per cent rise and last 32 per cent increased the overall efficiency by two per cent.

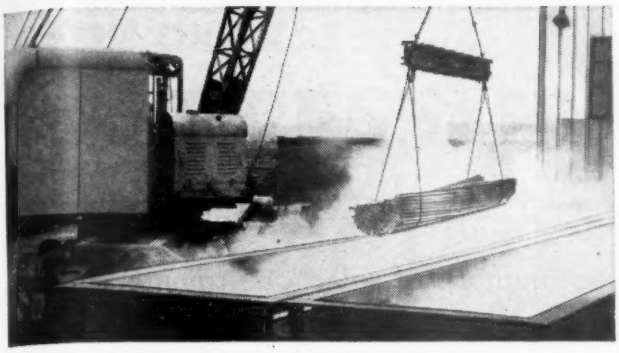
The recovery with the scraper at the trap is not a criterion to the results obtained. On some of our early runs, less than $\frac{1}{2}$ bbl of foreign materials was recovered, but an increase in efficiency of 6 to 8 per cent was obtained. In a number of cases we have received less than 5 gal of liquid and gained from 2 to 3 per cent in efficiency.

A scraper cannot possibly carry all of the foreign material it comes in contact with for the full length of the run; so there are two reasons for the above results. First, the majority of liquids and other foreign materials collect in low spots, producing a severe restriction at these locations. As the scraper passes, it breaks up these restrictions and scatters the material out. Second, after the materials are scattered, especially the liquids, they are exposed to a greater surface of the gas, allowing themselves to be absorbed or suspended in stream thereby carried into the nearest scrubber and collected.

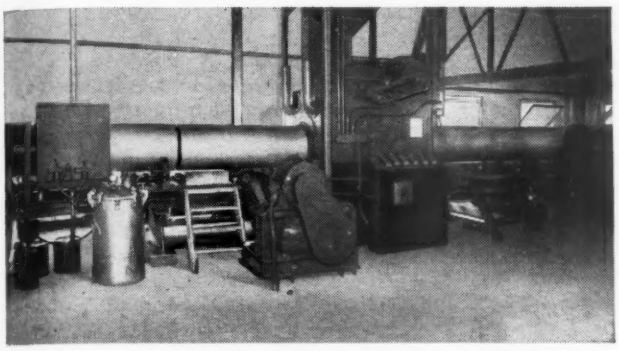
In many cases we have run from 3 to 6 scrapers before recovering anything. Then the next 2 to 6 succeeding runs would bring in large quantities of liquid and sludge, after which the recovery would start falling off until nothing was received.

Conclusion

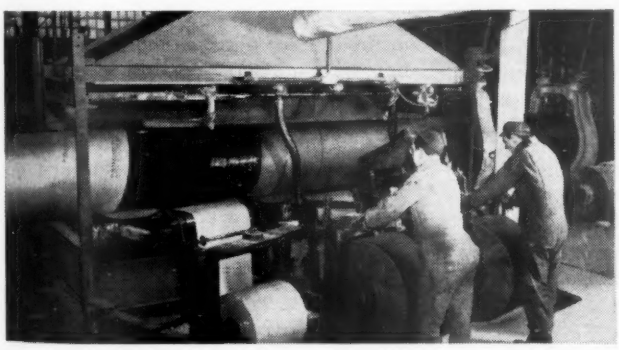
This discussion has covered briefly what has been done with scrapers, things to be appraised in determining if it would be economically sound to incorporate facilities in a system, and what you may expect to be able to do after the installation is made. Design engineers are realizing more every day that in new designs internal cleaning facilities are a "must." Each old system is a problem by itself, and the value of cleaning facilities depends on how big of a bind you may be in and will the expected relief be worth the cost of conversion. It is a small expenditure when compared to the cost of some of the conventional methods for overcoming such situations. The results and possibilities have been offered herein. * * *



HOT CAUSTIC DIP removes all cutting oil and grease. Pipe is then rinsed in clear, hot water and dried in warming room. Throughout Hill, Hubbell process, pipe is kept at 80-90° to prevent moisture condensation.



ROTO GRIT BLAST removes all mill scale and rust, cleans pipe to bare, bright metal, provides a slight "tooth" to hold coatings in positive bond. Priming coat is applied immediately after Roto Grit Blast.



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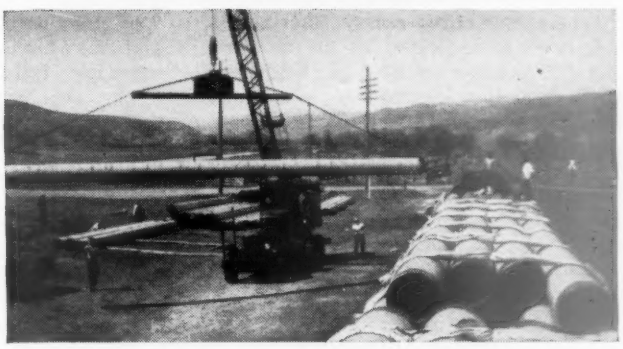

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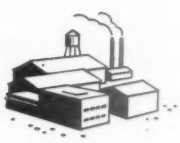

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Selection and Training of Engineers†

Better utilization of engineers through improved methods of selection, training, and orientation could help alleviate personnel shortages anticipated in coming years

MORRIS S. VITELES*

According to recent estimates, industrial and governmental requirements for engineering graduates during the current decade will be in the neighborhood of 30,000 per year.[1] An analysis of data on engineering school enrollments and of civilian and military needs (by the Engineering Manpower Commission of Engineers Joint Council) indicates that the number of graduates available for jobs in government and industry will be approximately 17,000 to 1953; 11,000 in 1954; 10,000 in 1955, and 16,500 in 1956. This analysis, and data from other sources[2, 3] indicate that the current shortage of engineers will extend for at least 5 to 10 years.

The extent of the current shortage in engineers is indicated in the fact, reported in a survey of 176 companies, made by the director of placement of Northwestern University, that these business and industrial concerns filled only 64 per cent of their requirements for engineering in 1952. It is anticipated that in 1953 requirements will be increased by 25 per cent, at a time when an appreciable percentage of graduates will be called to active military duty.

Competition Extensive

Under such conditions, it may seem academic to devote any time whatsoever to the consideration of improved selection techniques. On the contrary, it might seem better to turn attention toward the preparation of bigger and better booklets describing the company; to a more extensive recruiting program; to the use of propaganda techniques which will place the company in a favorable competitive position in meeting its needs for engineering graduates. The facts, (reported in the 1948 survey of "College Graduates in Industry" by the National Industrial Conference Board) that on the average about 300 different business firms approached each of 60 colleges for graduates in 1947, and that 2000 or more different business firms approached 3 of these colleges, may indicate that this is exactly what industry is doing.[5] Moreover, in some instances, it would appear that only a brass band is needed to complete the elaborate ceremony with which the newly hired young engineer is inducted into the organization and introduced to the vistas which spread out before the graduates of our engineering schools.

This situation is not one in which improved selection techniques can be used to best advantage. To say this is merely to point out the well-recognized fact that the efficiency of even the best validated selection method is very definitely a function of the size of the labor pool. The practical efficiency of most tests, and also of other predictors, such as the interview, falls off rapidly as the size of the labor pool diminishes because of the necessity of hiring increasing proportions of available applicants in order to fill the established quotas.[6]

Efficiency of Tests

Let us assume, for example, that in a company which is not using tests, 8 out of every 10 engineers hired have proved to be satisfactory employees. Using a test with a validity coefficient of .50 (as high as that of the better tests available for engineer selection) it would be necessary to reject 40 per cent of the applicants on the basis of test scores alone in order to improve selection to the point where 9 out of every 10 engineers hired (instead of only 8) will prove to be satisfactory to the company. With rejections for other reasons, it can be seen that a much smaller proportion of the applicants would be available for employment.

Assuming that the experience of the company using only traditional methods has been that only 6 out of every 10 of the engineers hired have proved satisfactory, with the same kind of test it would be necessary to reject 90 per cent of the applicants on the basis of test scores in order to reach the point where 9 out of every 10 men hired will prove to be satisfactory. There is hardly a company requiring engineers which could accept such an attrition of the "labor pool" of graduate engineers.

In presenting such figures certain assumptions are made concerning the quality of the applicants in the two situations; the degree of similarity between recruiting and selection methods, and the standards used in assessing the performance of the engineer. Disregarding, for present purposes, the statistical technicalities, a number of generalizations can nevertheless be formulated with considerable assurance.

The first is that the addition of tests to traditional techniques finds its most useful application (a) where the objective is to hire only the very top quality of engineering talent, or (b) where experience has shown that traditional methods have not resulted in the selection of engineers capable of meeting even moderate standards of performance. The second generalization is that the company must in most instances be prepared to sacrifice a substantial proportion of its already inadequate labor pool in order to accomplish such objectives.

Objectives Questioned

It is questionable whether the objective of a company should be consistently that of hiring only the "cream of the crop." There also appears no reason for assuming that a large proportion of engineering school graduates is incapable of achieving reasonable performance standards. As a result, it is also questionable whether, under current conditions, the addition of tests to traditional hiring techniques represents the most productive approach to the selection of engineers.

To say this is not to raise questions concerning the use of tests in selecting personnel for lower level jobs. A prime factor, in contrast to the situation at lower job levels, is that in hiring engineers we are dealing with a group which has already been rigorously preselected by the university, and with men who have already undergone an intensive training program designed to develop skills which they are ready to put to immediate use at the time of employment. Furthermore, this situation does not apply to companies where the

†Presented at the Transmission and Storage Conference, American Gas Association operating section, Chicago, Illinois, 1953.

*Director of Personnel Research and Training, Philadelphia Electric Company.

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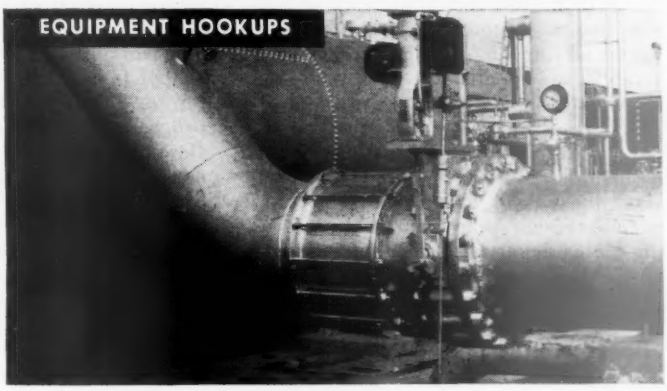

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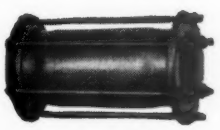
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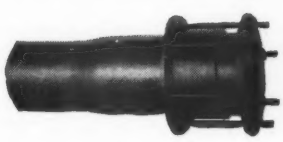
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stated aim in the use of tests is to select and employ only "cadets", as contrasted with "line engineers," i.e. to employ only young engineers who are viewed as raw materials for progress into managerial and executive jobs.

In earlier years, such a distinction was actually made in the selection of engineers by one company. In conformity with this policy, a passing score on a test battery was a requirement for acceptance as a cadet engineer. The tests, which were a "clinically" selected battery, included measures of over-all learning ability; of mechanical comprehension; arithmetical reasoning; problem-solving, and of practical judgment.

Experiments, conducted by other agencies,[7,8,9,10,11] have shown that these (along with tests of physics training and aptitude; spatial perception, and interest tests) are, in general, the types which prove to be the best predictors of success on an engineering job. Selection norms on the company test battery were established by giving the tests to approximately 300 engineering school graduates prior to employment.

In addition to preliminary screening of candidates by the employment division, those who had passed the tests were interviewed by representatives of the major departments of the company, and only those hired who were favorably rated by every departmental representative. In such interviews, observations and attention were focused primarily on interests, appearance, speech habits, attitudes, character and personality, while the tests were intended to measure only basic aptitudes. In fact, a comparison of pass-fail on tests with ratings given during the interviews showed no correlation between the two. Under such conditions, it was found possible to maintain a low separation rate among newly hired cadet engineers and to provide a core of highly capable young men for future development.

Methods Changing

The procedure described above has merit for purposes of what might be called "super-selection" — when the orientation is toward obtaining a group of men who are more or less tagged as promising candidates for filling top posts in the organization as vacancies occur through the years. It has considerably less merit in selection when the ultimate replacement of managerial and executive personnel is a secondary consideration as compared with that of filling vacancies on jobs which require an engineering background, especially when there is a scarcity of engineering school graduates. This situation helps explain why, as a matter of fact, policy in the selection of engineers by the company is in a state of flux, and why test results are not currently being given as much weight as in the past.

While I have referred to the situation in one specific company, it seems preferable to consider the problems of selection and training from a broader perspective. Approached from this point of view, the immediate need is not for the improvement of selection methods, as much as for focussing attention (a) upon the re-structuring of the training program to conform to the current situation, and (b) upon the more effective use of technically trained personnel through the re-engineering of engineering jobs.

Training Objectives

In my opinion, it is necessary to make firm provisions for the systematic training of all newly hired engineers. From the viewpoint of a sound organizational philosophy, as well as of the immediate practical situation, we have passed the point where training can properly be given only to a group of highly selected and favored engineering school graduates. This view does not imply absence of a need for building-up a pool of specially qualified individuals and for preparing them for middle and top management jobs. However, this is not the proper function of the training program for newly hired engineers, although progress during such training can be viewed as an aid in the selection of the more promising candidates for future training and ultimate advancement to top level jobs in the organization. From this point of view the training program for newly hired engineers may be conceived as having three objectives, viz.—

(1) to provide such men with an opportunity to do useful work under direction and with guidance designed (a) to sharpen the skills which they have acquired in an engineering school, and (b) to prepare them for effective careers as professional engineers in the company;

(2) to acquaint newly hired engineers with the nature of the company, its organization, the functions and interrelations of its various departments, its policies and practices.

(3) to give the company an opportunity to observe new engineers at work — to check on work habits and other traits to be considered in qualifying the engineer as a "regular" or "permanent" employee.

Useful Work Desirable

The first of these objectives — that of giving the young engineer an opportunity to do useful work under direction and with guidance — represents the most important objective of the initial training program. There is here a contrast with the traditional approach in training that has been to place emphasis upon giving the young engineer an opportunity to try out various jobs; look around and examine the opportunities in the company; get to know the various people with whom he will have to work and to identify those who can "help him move onward and upward in the organization."[12] To reject this traditional view — to place primary emphasis upon useful work — is desirable for four reasons:

1. First is that the shortage of engineers has created a need for people who can immediately apply the knowledge and skills they already possess. There is work that needs to be done and that will remain undone unless the young engineers are put to work on productive jobs.

2. The second reason is that engineering school graduates want to be put on assignments where they can do useful work. Thus, one conclusion from the survey conducted by the Edison Electric Institute is that "the graduate wants an initial opportunity to work where he can uilize his specialized training within a reasonable time."

3. The third reason is that no young engineer should be considered as "marked for responsible positions"[5] unless he has demonstrated that he possesses work habits and attitudes of the kind which can only be observed as the engineer participates in the productive work of the organization.

4. The fourth reason is that it can be anticipated that a proportion — possibly a major proportion — of the young engineers will find their level in some productive line job. It seems both undesirable and unrealistic to encourage such men to set levels of aspiration which they cannot possibly hope to achieve.

Orientation

While the core of the training program is useful work under direction and guidance, there is also need for providing the young engineer with information about the company; its organization; the functions and interrelations of its various departments; its policies and practices, etc. This can be accomplished through an orientation program consisting of conferences and systematic visits to company installations. Such orientation not only provides the young engineer with information about the company and its operation but also basic knowledge concerning the "opportunities for personal development" and professional growth in the company. Such a program also provides an opportunity to meet company executives, managerial and supervisory personnel who would, naturally, participate in the conferences and field visits included in the orientation program.

In order to make the program more attractive — specifically, to increase its attractiveness as a recruiting device, it might be extended to a total of 18 months with provisions (a) for two 3-month assignments in other units of the company and (b) an opportunity for the young engineer to transfer to some other department for permanent assignment if his long spell of work in the department to which he was initially assigned plus the orientation course plus the two shorter assignments leads him to the view that he would feel happier in this other department.

While suggesting this possibility, I nevertheless would be inclined not to include the shorter assignments in the

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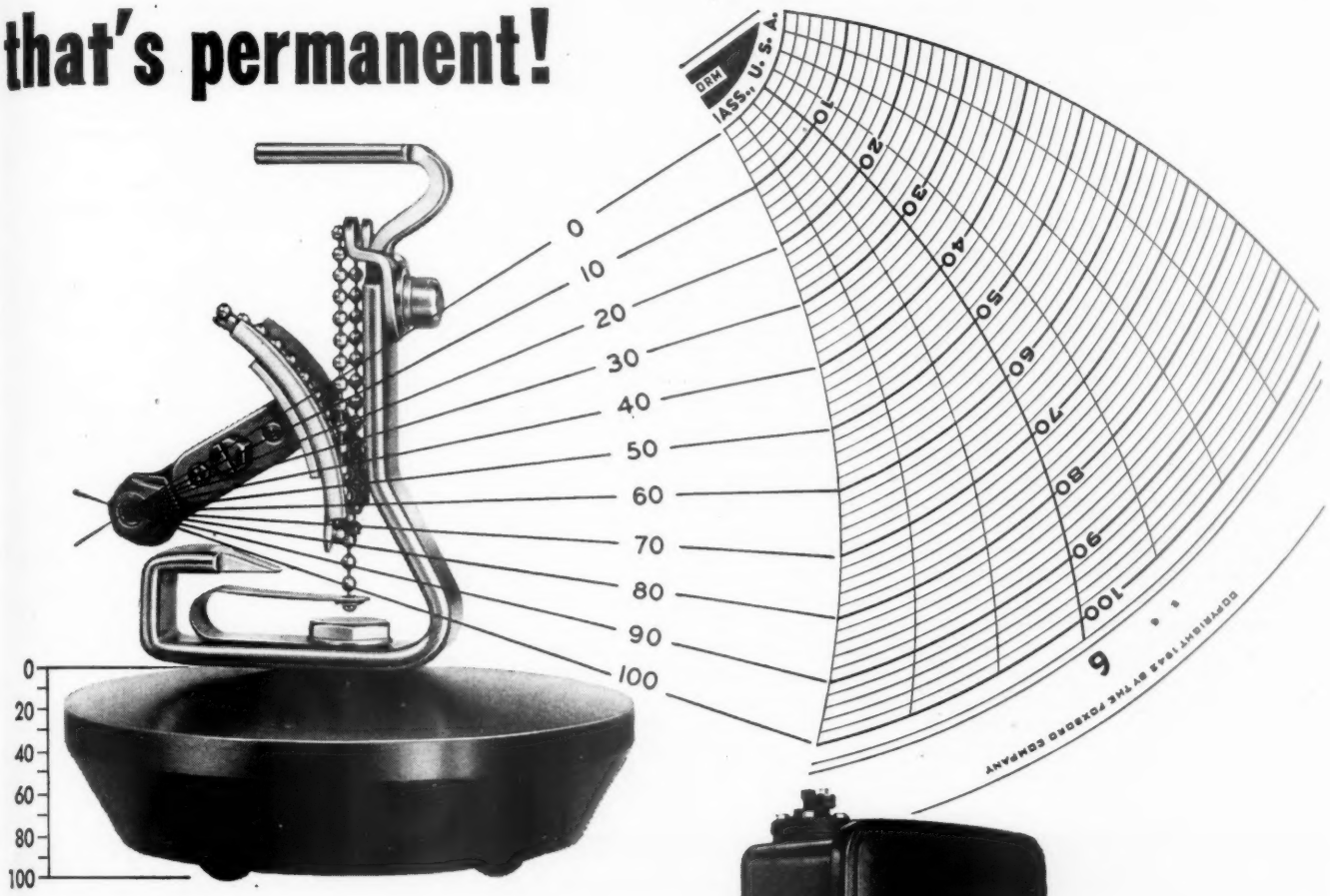

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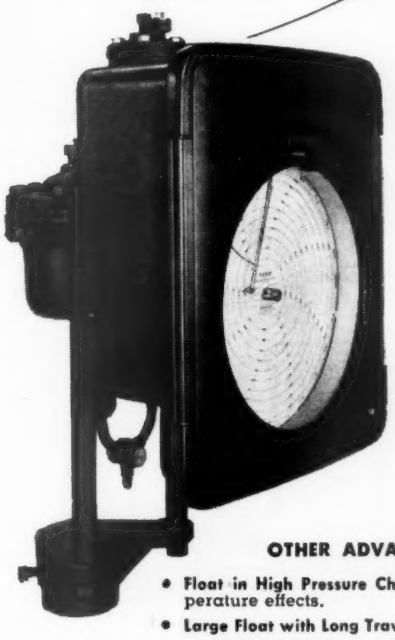

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initial training program, but to make other provisions for "cross-training" as part of an over-all four point developmental program. In order to meet the needs of the company for a pool of highly qualified individuals, and also to provide every engineer with a maximum opportunity for development within the limits of his ability and interests, I would suggest that provision be made for three additional steps in an all-around program of engineering and executive development.

Advanced Training

Step two in this program is to provide young engineers with opportunities to gain greater insight into technical and practical problems involved in design and operation than can be acquired in the initial program or through work experience alone. This can be done by setting up a systematic program of advanced engineering training to be made available on a continuous basis. This might take the form of well-planned scheduled monthly sessions in which technical personnel discuss engineering and operating problems in development and allied phases of company operations. This program might best be operated on an after work-hour basis. This not only represents the most practical arrangement, but also provides an indirect check on the interest of engineers in improving their usefulness to the company. The important point, however, is that systematic provisions be made for this kind of technical development.

Personnel Interchange

Step three would include provisions for the systematic interchange of engineering personnel of the company. Here I have in mind simply an interchange of men on existing work assignments. It means that periodically and on a planned basis the engineering department would "swap" engineering personnel with the operations department. Other departments would participate to the extent that they employ engineering personnel. It might well be that such exchanges would cause a certain amount of temporary inefficiency for short periods as changes occurred. I question whether such inefficiency would be serious in scope, especially if the program of technical development suggested under step two were followed. Perhaps the danger of inefficiency can be eliminated by limiting such exchange to engineers who were interested in testing the possibilities of other jobs and widening their knowledge and skill, and by definitely excluding those younger engineers who showed no promise of benefiting themselves or the company from such an exchange. Under any circumstances, temporary losses in efficiency would be more than offset by gains in flexibility on the part of engineers and by advantages in the way of improved interrelationships in the operation of the various units of the company.

Executive Development

The final step in this program would be in the form of an executive development program for a selected group of engineers who had demonstrated unusual promise for advancement. This might well be limited to men who had a minimum of fifteen years of service with the company and be confined to only those men who have shown themselves by performance, by interest in supplementary training and other activities as having potential for development in the middle management and top management jobs. Job rotation would be a feature of this program as it is of step three in the proposed program.

However, it would be job rotation of an entirely different order involving a series of assignments to supervisory jobs in non-engineering as well as engineering activities. In a large sense, this might be considered as an analogue of the job rotation program which has been successfully employed by one firm.

"Re-Engineering" Needed

A systematic program of training and development, such as that described above, can yield maximum returns only

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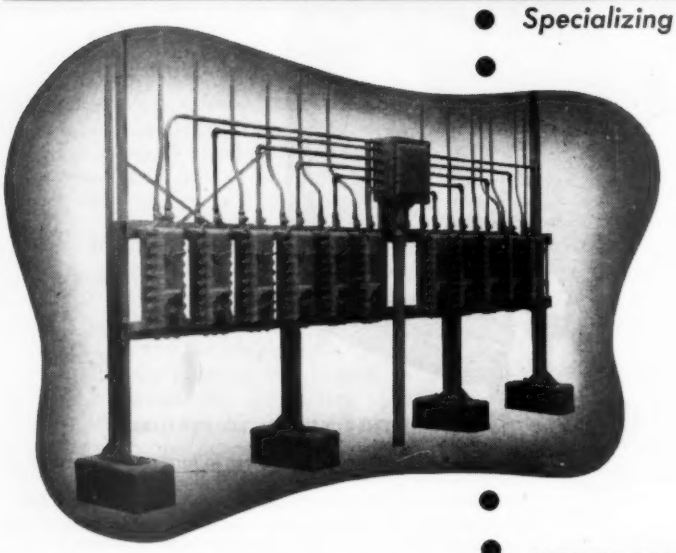

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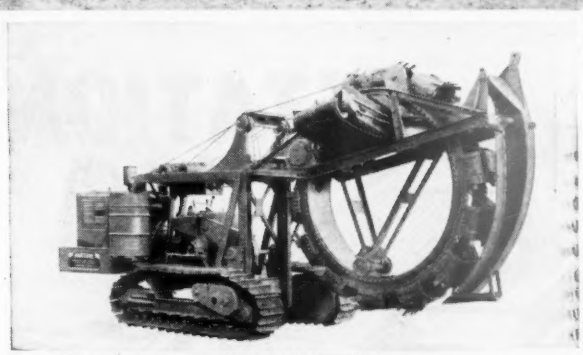
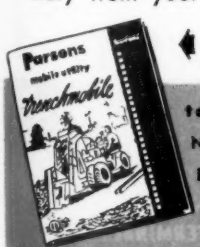


Wheel-type TRENCHLINERS® are available in 2 models. Cross-country 215 (above) has standard tractor crawlers, 55 h.p. diesel engine, digs 18 ft. per min., 6 ft. deep, 13 to 31 in. wide. Also: wheel-type 202.

Ladder-type TRENCHLINERS . . . 3 sizes, provide trench widths from 16 to 54 in., depths to 17 ft. Heavy-duty 250 (above) digs 16 to 42 in. wide, 12½ ft. deep, has 30 digging feeds from 6½ in. to 9¾ ft. per minute.



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P366PE

if it is restricted to engineers who are fully utilizing their time on engineering work. From recent reports[14,15] it appears this is not true in the case of an appreciable proportion of engineers. There is growing opinion that, in many instances, engineers are devoting a portion of their time — to duties which can be adequately performed by less capable and less skilled people. Under such conditions, no combination of improved selection methods and improved training methods will fully solve the problem created by the current shortage of engineers. There is need, in addition, for an analysis of what engineers actually do and for a subsequent re-engineering of the engineering job. This approach involves a consideration of:

(a) the possibility of "de-skilling" present engineering jobs by breaking down engineering positions into several simplified functions which can be handled by technically trained workers who are not engineering school graduates;

(b) the possibility of taking advantage of existing programs of secondary school technical training or enlisting the coopèration of secondary schools in the area served by the company in developing a program of preparing young people (not qualified for an engineering education but otherwise competent) to handle such lower-level technical jobs;

(c) the development of in-company training which will offer possibilities for upgrading competent young people in the organization to handle such jobs.

Conclusion

According to a recent report, "wise companies are depending less on recruiting (from a manpower market that hardly exists) to ease the engineer shortage. They're freeing their own engineers from details, improving communications, taking every step to increase individual productivity."[15] Here is a program which will contribute to the satisfaction of present employees at the same time that it helps the company solve its problems. To overlook this possibility — while centering attention upon improved selection and training of new engineers — is to sacrifice golden opportunity for combating influences conducive to low morale among engineers while simultaneously increasing the efficiency of the company. ★ ★

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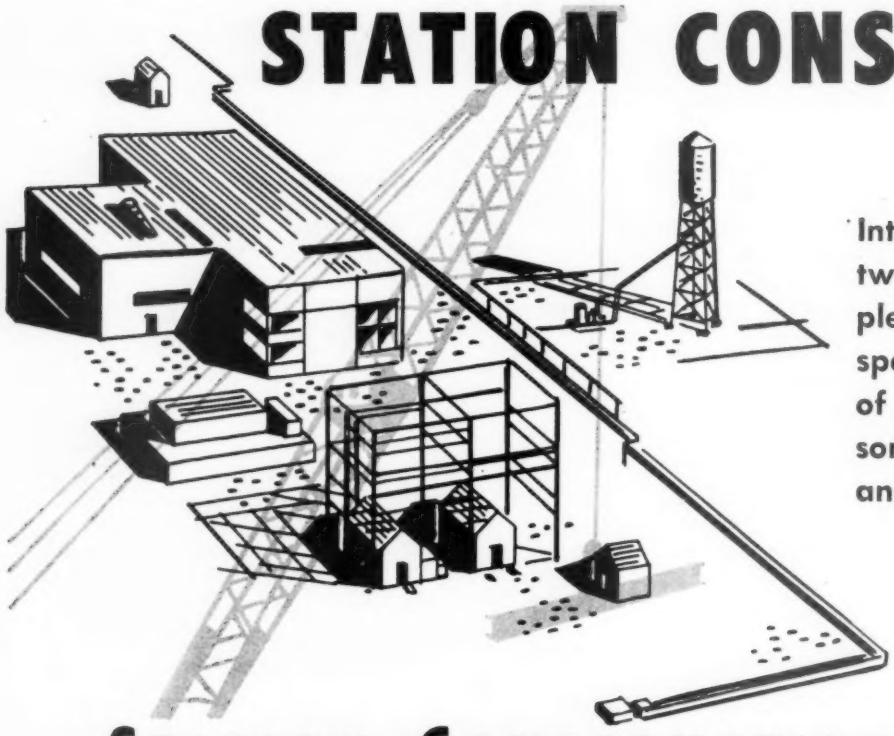
STATION CONSTRUCTION



Integrity and experience are two basic factors in our completely integrated organization, specializing in the construction of pump stations, gas compressor stations, tank farm systems and terminals.

STATION CONSTRUCTION COMPANY

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CRUDE OIL • OIL PRODUCTS • GAS & WATER PUMP STATIONS • TANK FARM SYSTEMS • TERMINALS

PIPE LINE PROGRESS

Dope gang preparing a string of A. O. Smith 26-inch welded steel line pipe for lowering in on the West Texas Gulf Pipe Line.

Biggest Inch to carry 381,000 bbl. per day from Permian Basin area

The West Texas Gulf Pipe Line, completed last February, is the largest single carrier of crude oil in this country. It has 465 miles of 26-inch pipe which extends from Colorado City in west Texas to Lucas, just outside Beaumont.

Present capacity of 301,000 barrels per day is being increased to 381,000 by the addition of intermediate pumping stations. Ultimately, capacity can be increased further to an estimated 440,000 barrels per day.

Crude oil from the Permian Basin area, containing more than 20% of the nation's oil reserves, is delivered to the Beaumont area and, through a 20-inch branch of 112 miles, to Longview, Texas, where it connects with other pipe lines serving Great Lakes and Ohio River valley refineries.

A considerable mileage of the 26-inch line is of A. O. Smith welded steel line pipe produced in Milwaukee and Houston. We are proud to have contributed to the construction of this, the Biggest Inch, as we have also to virtually every important petroleum products pipe line in the world.

A. O. Smith Line Pipe is available in a complete range of sizes and wall thicknesses, from 8⅝-in. to 36-in. diameters.

FIRSTS by A. O. Smith: Welded line pipe • Internally expanded pipe • Light-wall large-diameter pipe • World's largest producer of large-diameter welded steel pipe.

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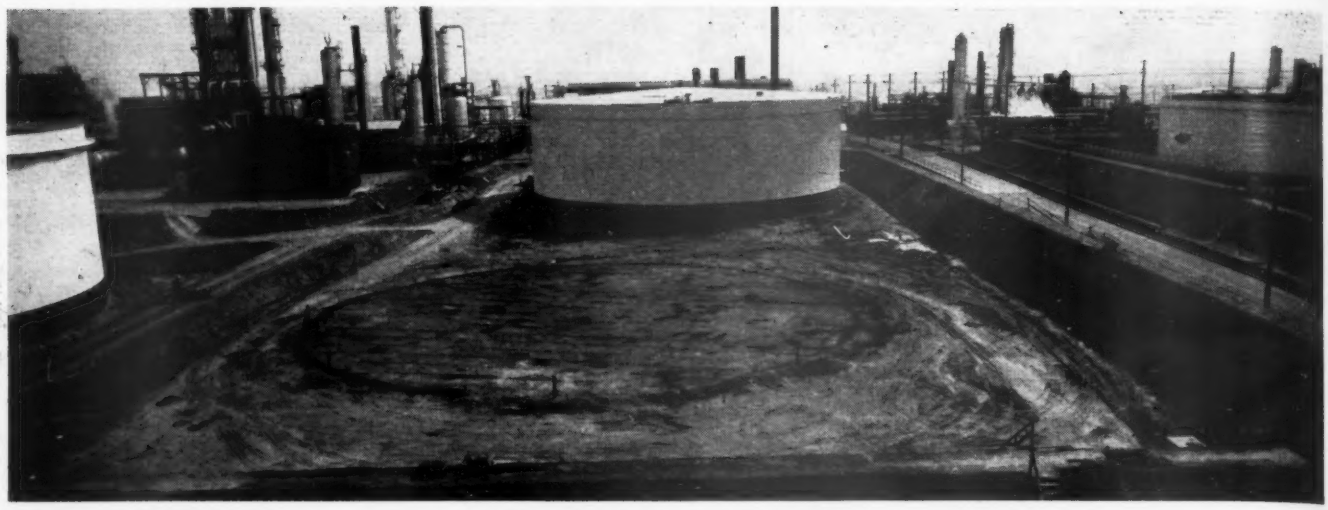
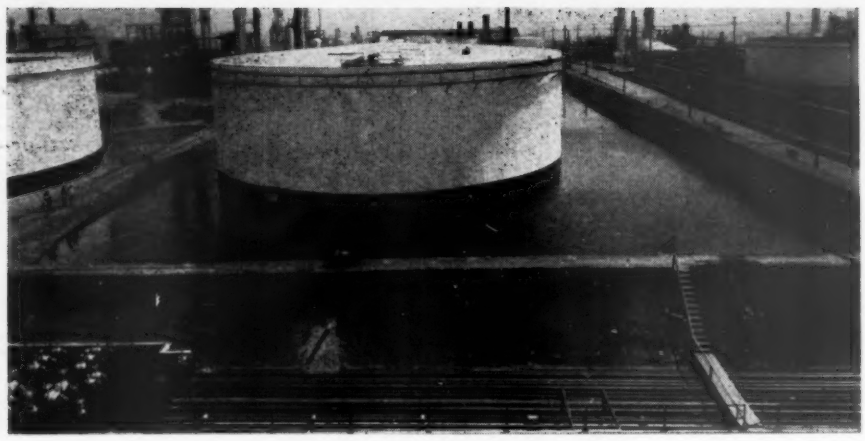
DEPENDABILITY THROUGH RESEARCH AND ENGINEERING





PREPARATORY work, top, had to be completed before the dyked enclosure was filled with water. Note in the foreground the circular sand base with the buffers used to guide the tank to its new position.

FINISHED movement, bottom, with the tank in its new location. The pneumatic towing winch can be seen on the frontal dyke with the cable still attached to the tank. All that remains to be done is to withdraw the water from the setting.

Archimedes Would Be Proud to Know

Hydrostatic Tank Movement

Saved Union Oil Company $55,000

RICHARD SNEDDON*

FACED with the problem of moving an 80,000-bbl tank, Union Oil Company engineers debated the various methods ordinarily employed for this purpose and finally came up with one of their own that was both simple and unique — they floated the tank to its new location, 200 ft away.

Basing their computations on the Archimedian principle that a body will displace its own weight of water, they figured that it would require a depth of 12 in. to float the 300-ton tank. They realized, however, that as the bottom of the tank left the ground, it would tend to become concave, thus, increasing the force needed to float the vessel. So, to be sure of enough clearance, 19 in. of water were pumped into the tank setting, which was a completely dyked enclosure. This provided a full 6-in. clearance under the "keel". It took some 36 hours to pump the necessary quantity of water into the dyked enclosure.

The walls of such a tank, in proportion to its dimensions, are only about one-sixth as strong as the sides of an ordinary coffee can and precautions were therefore necessary to prevent buckling and distortion, as the tremendous hydrostatic pressure involved exercised heavy strain on the bottom and walls. To give the vessel adequate support and strength during the moving process, a system of radial structural members was welded to the tank bottom and attached also to the shell. Between this and the supporting columns, other members were added, all of which was designed to give greater rigidity and prevent tank collapse.

A circular sand base was prepared at the new location and heavy pipe buffers were placed, as shown in illustration, to form a cradle that would guide the tank to its new position and hold it there until the water was withdrawn.

The actual moving was done with four pneumatic winches. One of these was employed to tow the tank, one was placed on either side as a means of keeping it in the proper path, and a fourth was used as a back-up unit to control the speed of movement. It took just 45 min to complete the transfer of the tank to its new site and the estimated cost of the performance was $5000, a sizable saving over the conventional process of dismantling and re-erecting, which for a tank of this size in a move of this sort could have cost approximately $60,000. * * *

*Pacific Coast Editor.

EXCLUSIVE

Westinghouse Microwave Letter

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONICS DIVISION, 2519 WILKENS AVE., BALTO. 3, MD.

Complete Microwave System Offers Coordinated End-Use Devices, Built-In System Protection

Westinghouse Type FR Microwave Radio assembly with Service Channel Panel and Alarm Panel (right). At left is the Remote Alarm Indicator.

Microwave is the latest medium for giving voice and control communications service. Westinghouse 2000 MC Microwave supplies this service in the best possible way—that of a complete system with full coordination of all elements. You get not only superior radio and multiplex equipment (combining high channel capacity with greater multiplexing reliability) but also excellent end-use devices and everything required (buildings, towers, surveys) for a complete, integrated installation. For even higher *system* dependability, special units are added to give overall system protection and added assurance of service continuity.

Service Channel Adds Efficiency

One of these special units is the Service Channel Panel, included with each Type FR Westinghouse Microwave Radio assembly. This channel provides party-line communications between all stations. It is not associated with the multiplexing operation of the 30 voice or 450 telegraph channels that can be provided by Westinghouse 2000 MC Microwave. In reality a 31st channel, the Service Channel is intended exclusively for installation and maintenance communication . . . designed to extend system efficiency and reduce operating costs.

Alarms Simplify Maintenance

Two more units of Westinghouse Microwave increase system performance by giving prompt notice of off-normal conditions. The Alarm Panel, associated with the Service Channel, reports up to six off-normal indications from up to 31 stations . . . on either the microwave system or on external conditions such as tower lights, low fuel supply or illegal entry. The second unit, the Remote Alarm Indicator, registers the nature of the condition and the station at which it is occurring.

Standby for Emergencies

Another system safeguard available with Westinghouse Microwave is Standby Radio equipment. A duplication of the operating radio equipment, this Standby simplifies automatic switching . . . can be arranged for instantaneous or delayed switchover. Standby also permits continuous system operation while preventive maintenance is performed on the operating equipment.

Superior End-Use Devices

All of these services of Westinghouse Microwave are derived from years of experience in microwave communications . . . from the knowledge that radio and multiplex alone are not sufficient for microwave service of highest reliability. Westinghouse realizes, too, the importance of end-use devices . . . is especially qualified, by virtue of a wealth of experience, in their manufacture and application. For full information about all of these matters, call your Westinghouse representative today, or write the Westinghouse Microwave Section at the above address.

Ask for our Microwave Booklet.

YOU CAN BE SURE... IF IT'S Westinghouse

J-02278

P 623.365.

REAR VIEW of the tower unit in erect position before being extended to 80-ft height. Unit is 24 ft in length collapsed.

SIDE VIEW of tower and trailer. Forward compartment is completely enclosed, houses radio equipment. Tower extends to 72 ft plus antenna.

Mobile Radio Tower Aids Communications

Lightweight tower and trailer unit used by Texas Eastern to facilitate its field radio operations

DEAN HALE*

MOBILE radio units have proved a very effective means of communication for Texas Eastern Transmission Corporation in its field operations, including line testing and repair operations and similar tasks. Until recently, however, there existed a problem of limited range between both vehicle-mounted units and a central communications station, due to the operating characteristics of frequency modulation equipment.

A major factor in securing increased range is antenna height. Company communications engineers realized a mobile tower on which they could mount an antenna would help overcome these limitations.

Six months ago they solved their problems with a ready-made mobile tower and trailer, that, with a few alterations and additions, could be used as a complete and compact central communications unit to meet practically any need. The tower-trailer unit was supplemented with a radio compartment and a gasoline engine driven generator to provide power for the radio.

The mobile radio unit used with the new tower had been a part of the company's regular equipment for nearly three years. It was easily adapted for use with the new tower unit without alteration.

Use of the tower unit began immediately after alterations had been completed in company shops and continued for two months in continuous service.

EXCLUSIVE

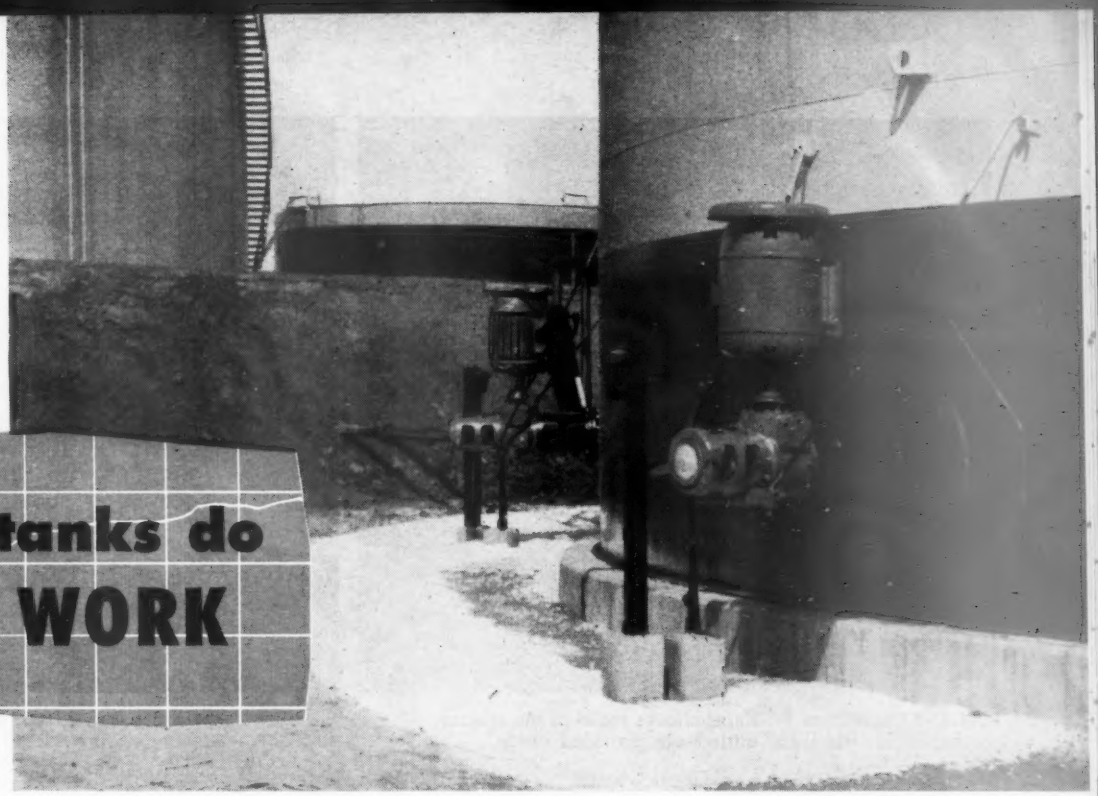
Tower and Trailer

The two-wheel trailer unit is very light, very mobile and extremely easy to maneuver. It hitches easily to the pulling vehicle and can be pulled by a passenger car, station wagon or small truck.

The three-section aluminum tower, of girder construction and triangular in shape, is 24 ft long when collapsed. It extends to 72 ft and an 8-ft antenna on the mounting mast gives it an overall height of 80 ft. The tower is equipped with lightning protection through a ground rod that fastens to the base of the tower.

Weight of the entire unit is 1200 lb.

*Editor, Oil and Gas Pipelining.



LIGHTNIN MIXERS in service at this pipe line tank farm keep B. S. & W. in uniform suspension in the crude. They eliminate the need for periodic tank cleanout.

Make your tanks do 12% MORE WORK

CONTROL B. S. & W. to get extra storage capacity . . . *at no extra cost*

If yours is like many tank farms, bottom sludge may be stealing 12% of your tank storage capacity.

You can say good-bye to this costly nuisance—for good—by installing LIGHTNIN Mixers to control B. S. & W. in your tanks.

You can save money four ways by using LIGHTNIN Mixers:

1. You increase tank capacity, because LIGHTNINS prevent bottom sludge buildup.

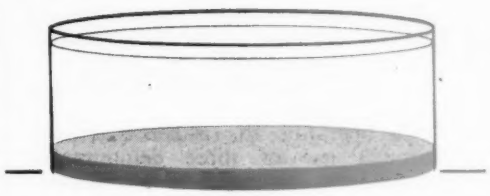
2. You save petroleum values often lost in the sludge (a 2-foot level of sludge in a 120-foot diameter tank may contain 4,000 barrels of merchantable material).

3. You save tank cleanout costs.

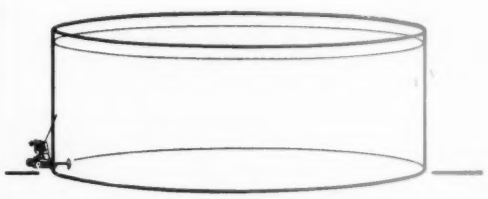
4. You eliminate tank downtime for cleaning.

Because of these savings, LIGHTNIN Mixers have paid for themselves in as little as three weeks! We can show you figures to prove this.

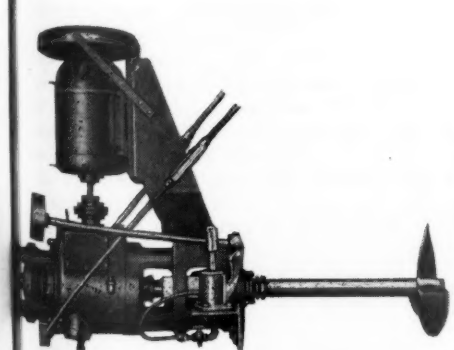
Be sure to get LIGHTNIN Mixers—they're *guaranteed* to do the job right. Full satisfaction—or your money back. This unique guarantee is backed by thousands of successful installations in pipe line company and refinery tank farms. Sold by factory-trained engineers, experienced in serving the oil industry. Specify LIGHTNIN—and be sure.



BEFORE USING LIGHTNIN MIXERS
Diameter—120 ft.
B. S. & W. level—2 ft.
Storage capacity lost—4,000 bbls.



AFTER USING LIGHTNIN MIXERS
Diameter—120 ft.
B. S. & W. level—None
***NO* storage capacity loss**



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XUM

ENGINEER Robert W. Bains checks radio in the special compartment. Electrical outlets are provided inside.

THIS 3½-kw, 110 v, a-c generator, driven by gasoline engine, provides ample power for radio operation.

Construction of the trailer includes both steel and wood. Framing of the bed and tower supports is steel. A wooden floor for the bed, to support the generator and accessory equipment, and an enclosed radio compartment at the front of the unit was built in Texas Eastern's shops.

In operation the trailer is leveled through use of three demountable screw jacks arranged in a triangular manner, two at the rear and one at the front.

Six guy wires are used to brace the tower, three fastened at a two-thirds distance up the extended tower (48 ft) and three fastened to the top (72 ft extended). They are spaced at 120-deg intervals around the tower. On level ground, the guy wires extend out to fastening stakes at points on a 40-ft radius from the base of the tower.

Power and Radio Equipment

The 3½-kw, 110 v, a-c generator, driven by a small 10-hp gasoline engine, provides plenty of power for operation of the radio equipment. It can also be used to operate floodlights and other electrical equipment requiring 110 v, a-c power as the occasion arises. There are several a-c outlets in the radio compartment where power cables can be connected. Capacity of the generator's fuel tank is sufficient to allow it to run approximately 10 hours without refueling.

The mobile radio unit used in combination with the tower is composed of a 60-watt, 10-tube FM transmitter and and 18-tube FM receiver, operating on a frequency of 48.94 mc. Normal range for voice communication with the tower is approximately 25 miles, varying with terrain and other conditions. Both units are very compact, occupying a space 22-in. square and 10⅝-in. high.

READY to go is the mobile tower unit, complete with equipment. Engineers Bains and O. B. Slaton check the tie-down cables trailer hitch. Texas Eastern communications personnel use station wagons equipped to haul their equipment and each vehicle has a trailer hitch for use in pulling the tower unit.

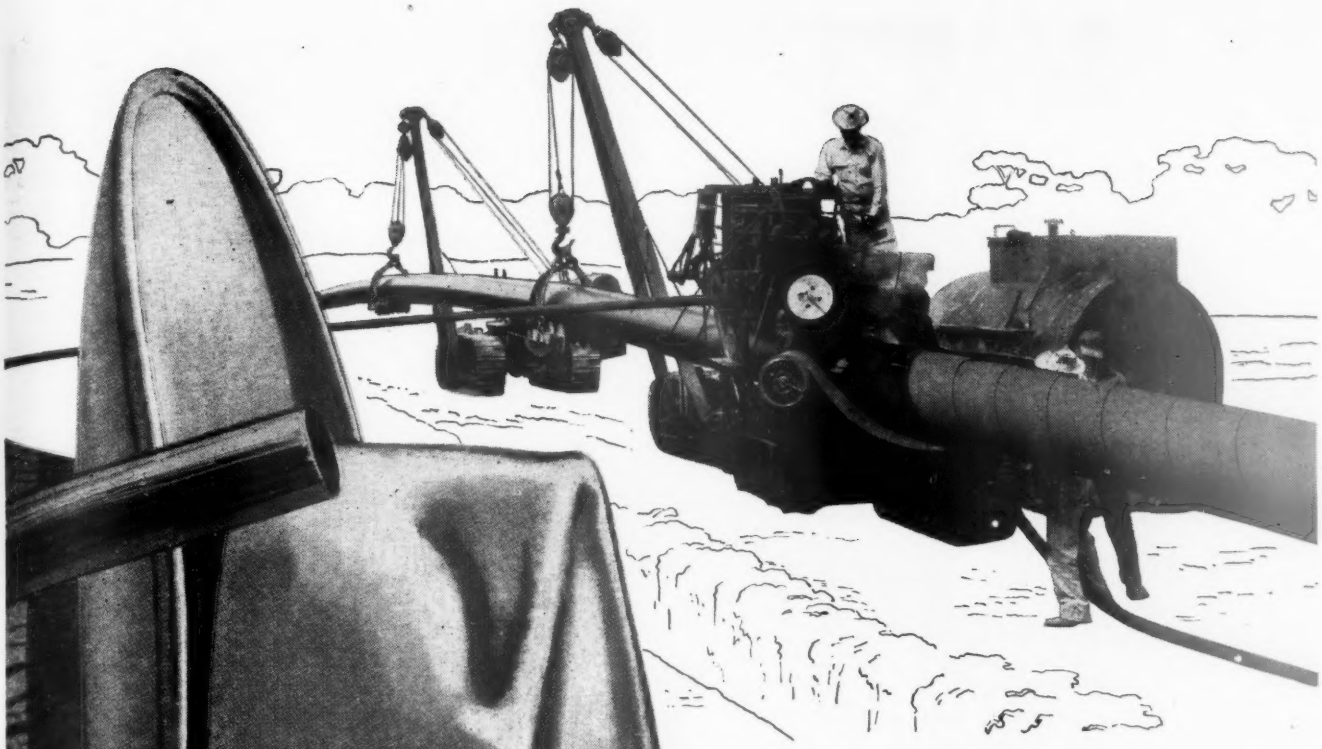
Operation of Unit

For operations in the field, Texas Eastern engineers use station wagons, which are designed to carry their special equipment, and each station wagon is equipped with a trailer hitch to facilitate use of the mobile tower.

Because the unit is light and maneuverable, it can be hauled anywhere the towing vehicle can go. Putting the unit into operation has become a rapid procedure.

The communications personnel can move onto a location, unhitch the trailer, attach the antenna, raise the tower, and guy-down in one hour. In event of emergency, where speed is vital, the radio can be on the air within 15 to 30 min after arrival on location and before the unit is completely set up. One man can set up the unit, but it is preferable to have two men on the job for safety purposes.

Weight of the tower is centered on a base point that has a screw jack built in. The jack takes weight off the trailer pivot points, which then serve to steady the unit and keep it perpendicular. A pocket level is used to level trailer. ★ ★



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YOU don't have to guess about the uniform top quality of *Pitt Chem* Modified Enamel. Look at its written specifications —check its softening point, penetration, ash, etc.—and you'll know the rigid standards each drum *must* meet. Then watch a pipeline crew roll when they're coating with *Pitt Chem,* and you'll know that these enamels actually do heat up faster, flow better from kettle to pipe and coat more pipe per day.

Pitt Chem's *specified* top quality means better protection underground, too, for it allows a better bond and greater resistance to soil stresses and varying service temperatures. ● Write today for *Pitt Chem* specification sheets . . . or any help you may need on your particular coating problem.

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★ Modified Grade Tar Base Enamel
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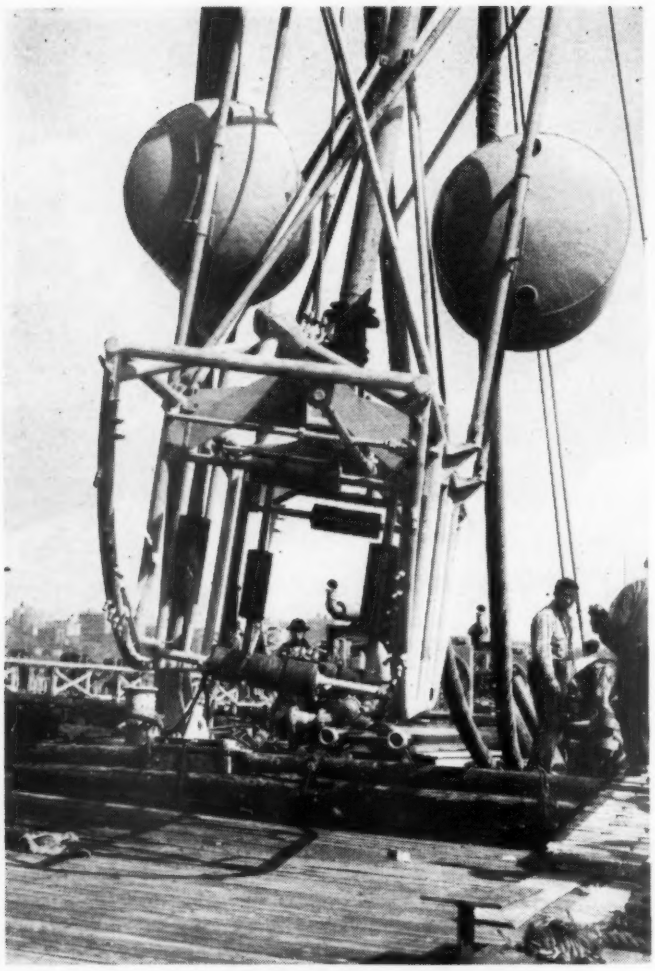


JET TRENCHER designed by S. V. Collins for use in lowering Transcontinental Gas Pipe Line Corporation's Hudson River crossing gets a final check before lowering in river.

ONE of specially constructed 2700-lb river weights, prior to being lowered to a saddle position on Transco's gas line. During job, 66 weights were used to hold line in place.

Lowering the Hudson River Crossing

A special underwater jet trencher, divers, dredges, and a full-moon were combined by Transcontinental Gas Pipe Line Corporation engineers to do the job

I. W. DODS*

WHEN the U. S. Army Engineers decided in 1951 to deepen the Weehawken Channel of the Hudson River in the New York City area, engineers of the Transcontinental Gas Pipe Line Corporation were asked to lower the company's 26-in. pipe line crossing under the river, which extends from Edgewater, New Jersey, to 134th Street, New York. Work on the project was delayed until this year by two other crossing projects, the Arthur Kill crossing and the Narrows crossing.

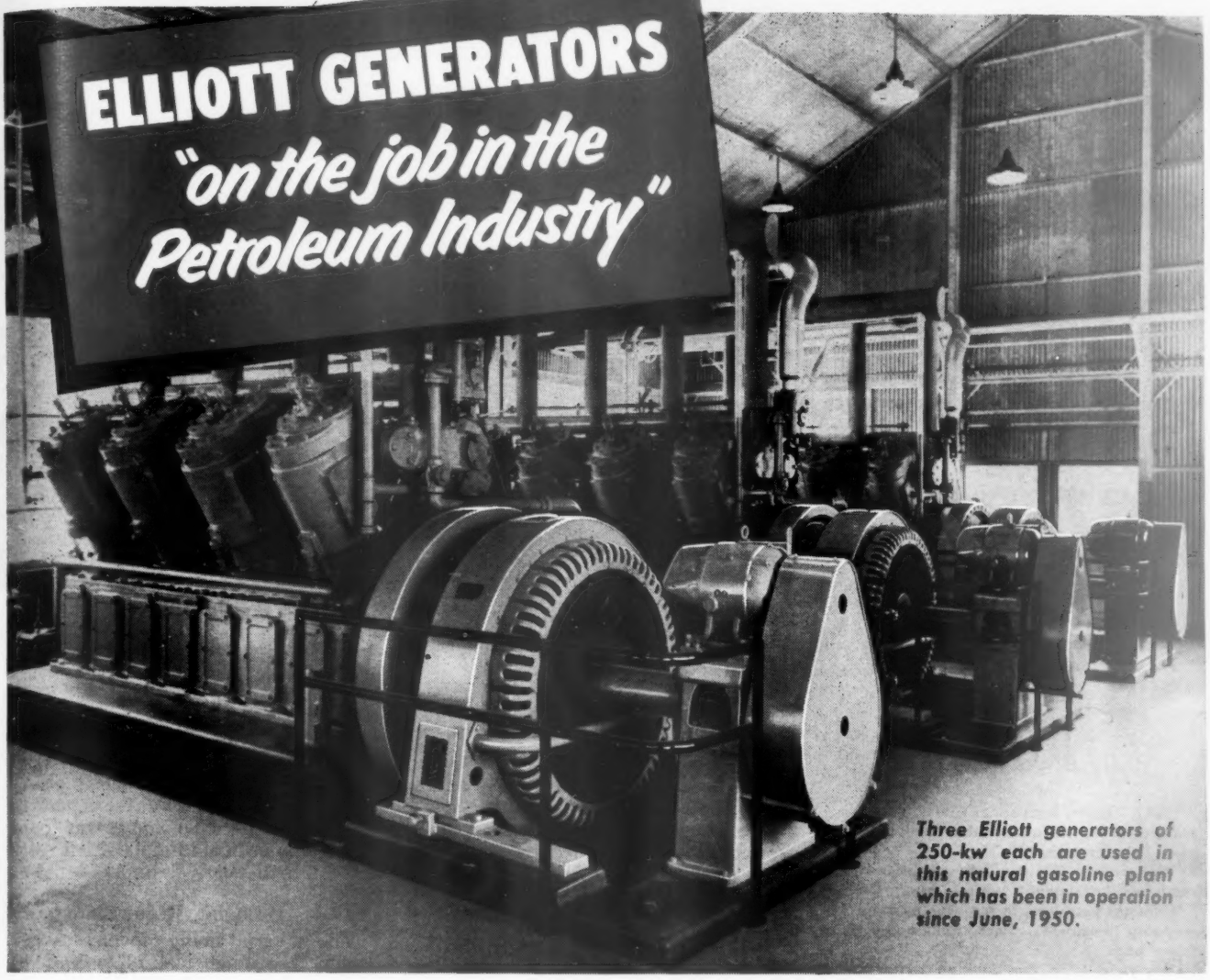
Transcontinental engineers decided to jet the pipe down to grade, although this method had been tried before with poor results. With experienced gained in jetting the West White Lake line to grade, however, they felt the same type of jetting operation would lower the Hudson crossing.

A special underwater trencher patterned after one used on the West White Lake line was designed for the project by S. V. Collins of Collins Construction Company, Victoria, Texas. Collins also designed river weights that could be rolled along the pipe, to allow divers to work in shallow water and not have to wait for slack tides.

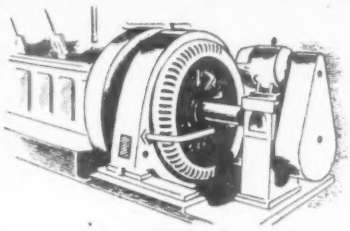
Prior to starting actual water operations, barges and equipment were assembled at the starting point. Gates Brothers, Inc., of Little Ferry, New

*Senior pipe line engineer, Transcontinental Gas Pipe Line Corporation, Houston, Texas.

ELLIOTT GENERATORS "on the job in the Petroleum Industry"



Three Elliott generators of 250-kw each are used in this natural gasoline plant which has been in operation since June, 1950.



This very competent-appearing installation supplies all necessary electrical power for pump drives, lighting, and other power needs in this natural gasoline plant in Texas.

The three generators are Elliott units, 250-kw each, driven by Ingersoll-Rand gas engines. In these generators Elliott "Fabri-Steel" construction is used throughout, providing the highest degree of rigidity plus the strength that only steel can give. Note that easy access to the rotor is gained swiftly by removing the bolts in the stator feet and sliding the stator along the extension of the bed, to clear the rotor.

For full data on Elliott generators, consult your local Elliott representative, or write Elliott Company, Ridgway, Pa.

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HOT DOPE

Straight from the Kettle on *PIPE PROTECTION*

★

By Boyd Mayes

"Why," asked a pipeliner friend, "do you loaf around the entrance to that bank almost every Tuesday noon?"

"Not loafing; just the shift we picked to watch our investment," we told him.

"Thought you were in the pipe coating & wrapping business . . . not banking," he ribbed back.

"Everybody's in the banking business," was the best answer we knew. "We got in the pipe coating and wrapping business through the front door of that bank and we've been watching each other ever since. Bought a share or two of their stock to keep a closer eye on 'em. Being 'in' with a banker is as good as being 'in' with a grocer, and an investment in a bank share comes next, to our way of figuring, to having a house to come home to and car to drive to work. Besides," we told our inquisitive friend, "we got an unforgettable lesson in the fine art of finance at the ripe old age of 14 back in our East Texas piney-woods hometown. Decided to go in the sign-painting business, found it took $10.00 capital outlay and hit the local bank president up for a loan."

"Sure," he said, "just sign this note for $10.00," and shoved *nine* one-dollar bills across the desk. The note was signed when we counted the money.

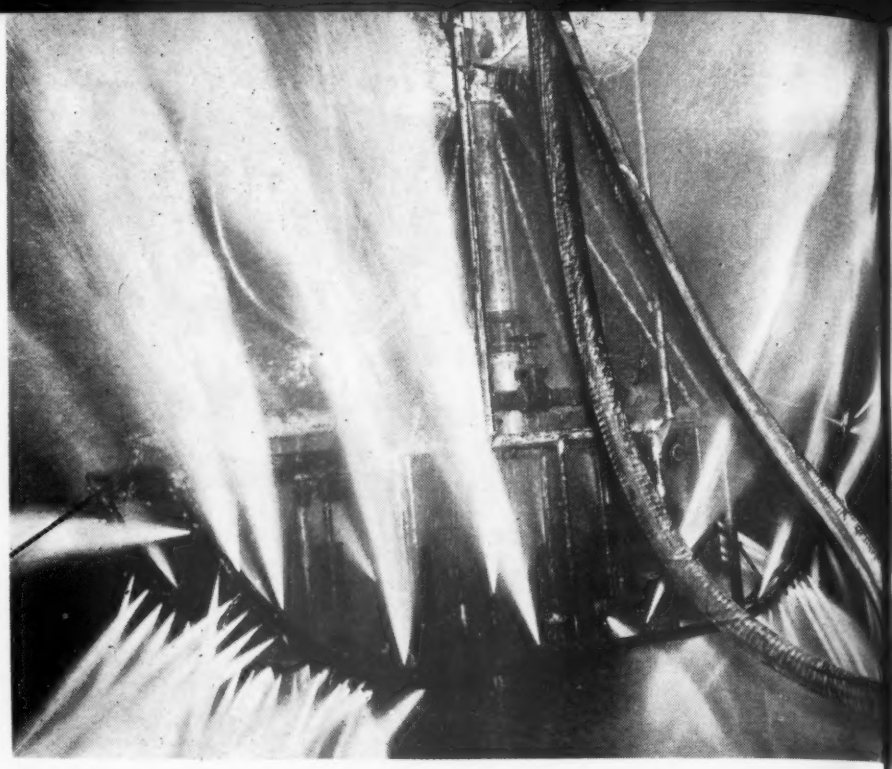
Figuring banks, and particularly bank presidents, didn't make mistakes we asked in a low, and humble, tone of voice: "But where's the other dollar?"

"Oh . . . *that* . . ." he explained with a broad smile and a hearty slap on our back as he ushered us to the door, "*that's* interest taken out in advance!"

That day was the beginning of our dream to someday own a part of a bank . . . even one share!

MAYES BROS.

1130 McCarty HOUSTON, TEXAS OR chard 7566



THIS close-up photo shows highpressure jets in action. Large hoses to right carry water and air under extremely high pressure from special pumps on trenching barge.

Jersey, supplied the marine equipment and labor for the project.

This equipment included two pumps of 320-hp each, capable of delivering 2000 gal of water per minute through a three-stage centrifugal pump. Compressed air was provided by two 315 cu ft air compressors manifolded together. Two 30-ft by 90-ft barges were used to float the equipment. These barges were equipped with deck winches so that anchors could be run out to hold the barges in the tides.

Within a month all the equipment was on the water and the actual trenching operation was begun. The trencher was lowered down over the line with the water jets cutting through 14 ft of mud until the trencher was on the line. A diver was then sent down with a hand water jet to cut under the pipe and to latch the bottom rollers which clamped the trencher to the pipe.

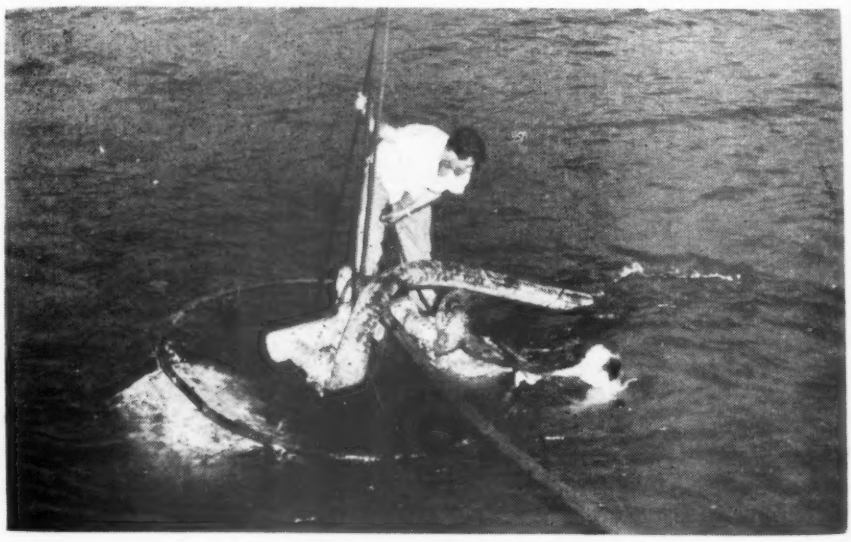
Water and air were then pumped down to the trencher and it was found the equipment could make 25 ft to 50 ft of trench every 8 hours.

Dredging Required

The material being moved was very "soupy," so much that 50 to 60 cu yd of material were being removed for every lineal foot of progress. Trenching in this manner was continued with the hope that the material would become more stable.

It was finally decided, however, that the overburden could be removed more

SAMMY COLLINS, in water, and his marine superintendent, Jean Johnson, put a cable sling on jet trencher in preparation to lifting it aboard trenching barge.



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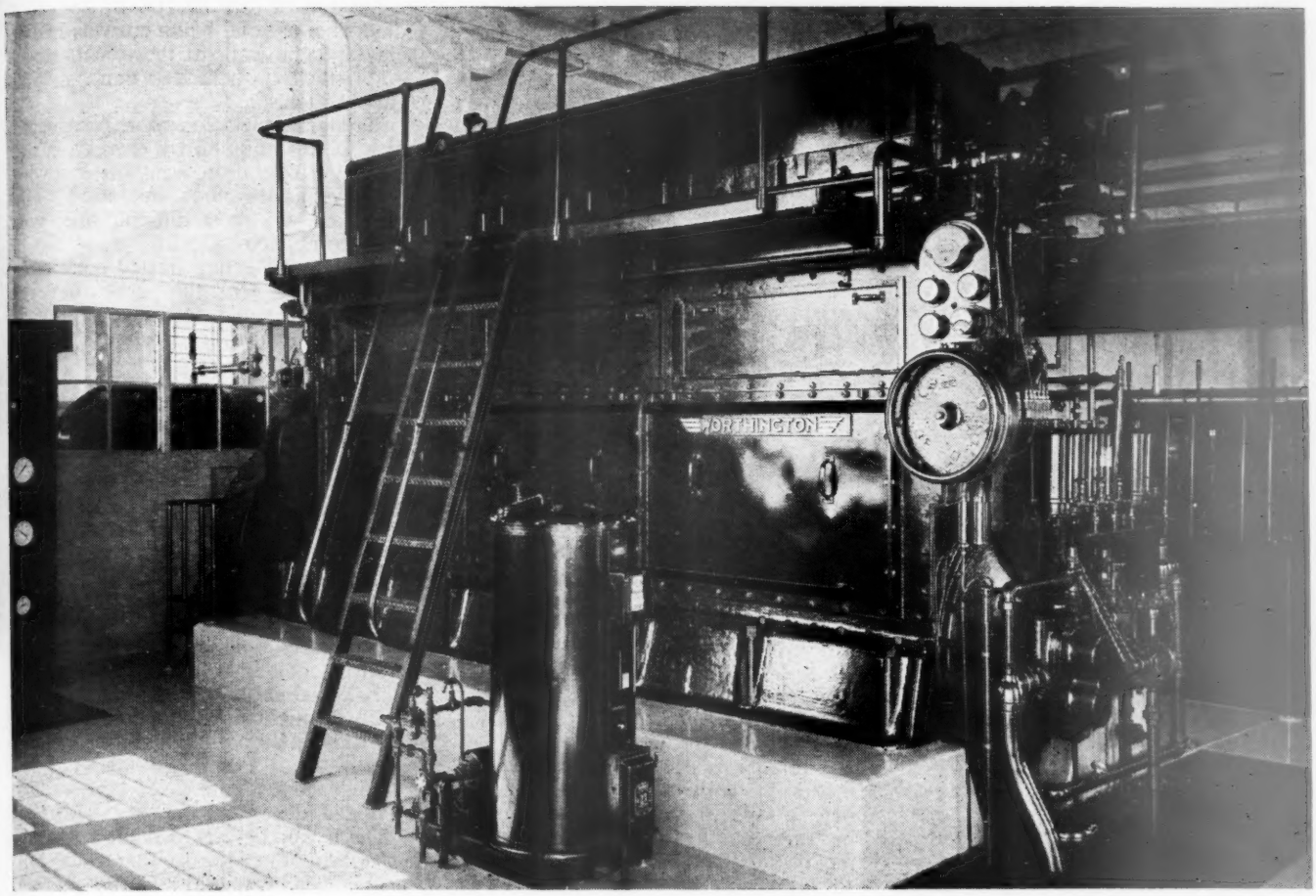

No Standby Needed

Worthington Reliability Saves Thousands of Dollars in Investment Cost

Here's one of twelve Worthington Diesel engines used exclusively on a large oil pipe line running across Texas.

They power the pumps which maintain a constant flow of crude oil from field to refinery.

In none of the pumping stations is there a standby engine. The pipeline company is confident that its Worthington Diesels will *stay on the job.*

Portable pumping units are connected into the line during routine maintenance checks.

Engine fuel is raw crude bled from the line. This is a severe application. But Worthington—one of the first to utilize crude for Diesels—knows how to lick the problem.

For any engine application, call on Worthington—an engine for any fuel: oil (crude or regular), gas or "dual fuel." Worthington's complete line of engines assures you of the most economical operation no matter what fuel you use.

For further information, write Worthington Corporation, Engine Division, Buffalo, New York.

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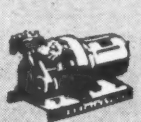
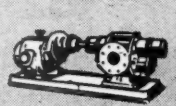
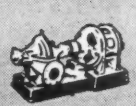
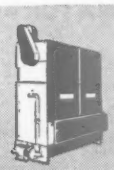
Gas Engines, 190 to 2880 hp
Dual Fuel Engines, 345 to 2640 hp

WORTHINGTON-BUILT AUXILIARIES


Engine Starting Compressors


Oil Transfer Pumps


Cooling Water Circulating Pumps


Evaporative Type Engine Water Coolers

STANDING beside specially designed roller weights used to hold line in place beneath mud are the men responsible for successful completion of trenching and lowering project. Left to right are Sammy Collins, Collins Construction Company; I. W. "Spider" Dods, Bob Gates, Gates Brothers Marine Service; and Jean Johnson, Collins, marine superintendent.

economically by other methods. Transcontinental's chief engineer, R. H. Crowe, contracted with a dredging company to attempt the removal of some of the overburden.

The trencher was shut down and a large bucket dredge was brought in. The dredge operated 24 hours a day, six days a week. A constant check was maintained to insure the dredge position was over the pipe.

A ditch was dredged on either side of the pipe with the idea in mind that material over the pipe would run into the ditches, thus cutting down the thickness of the overburden which was slowing progress.

The dredging was continued for four weeks and 140,000 cu yd of material was removed and placed in bottom dump scows and hauled out to sea.

Upon completion of the dredging, there were two ditches, one on either side of the pipe and material had not run into them as had been anticipated.

Full Moon Gives Aid

Help came in the form of a full moon. The full moon caused exceptionally strong tides, which increased the velocity of the current and caused the material over the pipe to slough off, decreasing the overburden from 14 ft to 6 ft.

The trencher was then started up again and progress on the project was much more rapid. Trenching was increased to a rate of 100 to 200 ft a day. The material being cut was heavy clay and the walls of the trench stood up vertically where the trencher had cut through.

Dredging operations were completed in a month and shortly thereafter the trenching operation went on a seven-day, 'round-the-clock operation. The first pass, the most difficult one, was soon completed.

The trencher then started back over the pipe and, with the overburden removed, was able to make approximately 1000 ft every 24 hours.

The pipe was covered with wood slats 1-in. by 2-in. and 12 ft long, as a protection to the Somastic coating applied when the line was installed. These slats continually caught up in the roller of the trencher and had to be cleared by a diver.

Divers were used extensively throughout the operation as the operation was continually being hung up on foreign objects such as large construction timbers, old piling, truck tires, boiler grates, and other such objects.

After making 11 complete passes and several short passes, the line was finally brought down to grade. Three and one-half months after the job began, the Army Engineers witnessed the probing survey and gave approval to go ahead and install the roller weights.

These weights are designed to roll along with the pipe so that they can be installed in shallow water and be pulled out along the pipe. Due to the hardness of the material beneath the pipe, the idea of rolling the weights was abandoned and each weight was put on, one at a time, by a diver.

Six to seven weights were put on the pipe at every slack water, which occurred four times each 24 hours. The addition of these weights increased the negative buoyancy so that the pipe now weighs minus seven pounds per lineal foot in 90 lb per cubic foot silt.

The entire operation lasted 102 days, with 21 of these days being used for dredging. The line was in service during the entire operation.

Acknowledgment

To *Transgas* for permission to publish this article. * * *

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(Formerly: Pelican Well Tool & Supply Company)

Johns-Manville announces a new lightweight, reinforced asbestos pipe line felt . . .

New Transhield Asbestos Pipe Line Felt

. . . designed for low cost tear-free application

Transhield is a lightweight felt, reinforced with continuous glass yarns, parallel spaced on ¼″ centers to give tear-free application strength. Made of coal-tar saturated asbestos, Johns-Manville Transhield Asbestos Felt acts as a continuous barrier to shield pipe line enamels from earth loads and soil stresses.

As an outer sheath to retard cold flow, Transhield takes advantage of the full thickness of the enamel coating—working effectively toward preserving a continuous film of enamel on the pipe line.

Long-Length Rolls—Available in 800-ft. rolls (14″ O.D., 2″ I.D.) for traveling power-driven coating and wrapping machines. Other lengths can be furnished to suit your method of application. Widths are from 2″ to 36″.

• • •

Johns-Manville has developed three wrapping materials for pipe line protection:

J-M 15-lb. Asbestos Pipe Line Felt (perforated or unperforated)—for severe soil conditions.

J-M Transhield Asbestos Pipe Line Felt—for average soil conditions.

J-M Trantex polyvinyl pressure sensitive tape—for pipe line corrosion protection where ease of application is important such as for emergency repairs and for coating field joints of mill-wrapped pipe.

For further information write Oil Industry Department
Johns-Manville, Box 60, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville ASBESTOS PIPE LINE FELT

MEMBERS of the 348th Engineer Pipeline Company finish assembly of pressure gage on line after installing new gasket to replace one that had blown a few hours earlier.

ARMY pipe liners tighten a clamp on a 6-in. line used to carry military fuel supplies. Equipment used by military pipeliners is designed for mobility and ease of assembly.

Citizen-Soldiers Learn Pipelining

Flexibility is the key to Army pipe lines — equipment is designed for mobility, speed

PIPELINING is not an exclusively civilian occupation. To the armed forces, pipe lines are a valuable asset in peace or war. In the Army, the task of building and operating pipe lines is a function of the corps of engineers, who lay and operate lines to carry fuel and other products needed for trucks, tanks and air craft.

To do this job, they must continually keep up with modern pipe line methods of construction and operation. Besides being technicians, they are also soldiers, which means they must be well versed in handling military weapons as well as handling pipe, valves, pumps and meters.

Presented here are a group of photographs of the 348th Engineer Pipeline Company during recent training at Fort Belvoir, Virginia.

The 348th is designed to be able to construct up to 15 miles of line per day in theater of operations or operate a

BOLTED steel storage tank is inspected shortly after erection by a member of the 348th.

SOLDIER-TECHNICIANS install new elements in a separator unit which removes water and other foreign material.

ALMOST ready for service is this filter as GI pipeliners complete task of bolting on a cover.

A VALVE gets a proper setting. In background is a gasoline-engine driven centrifugal pump unit.

line that includes 16 pumping units complete with tank storage and other facilities.

The Army Engineer Pipeline Company uses 6-in. pipe, bolted steel tanks designed for mobility, and gasoline-engine driven centrifugal pumps. The pump units are placed at 15-mile intervals and capacity of a 100-mile system is approximately 12,000 bbl per day.

On active duty, the members of the 348th work as a well-trained team, performing their jobs as military pipe liners with precision and speed. In civilian life they are government employees, small businessmen, farmers, teachers, bankers, and engineers.

A reserve unit, the 348th spends two weeks each summer at a regular army post, usually Fort Belvoir, putting into practical application the knowledge accumulated the other 50 weeks of the year in regular meetings at Fort Lee, Virginia. The 348th has its own classroom, offices, and supply room at Fort Lee.

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HERE'S NEWS FOR YOU!

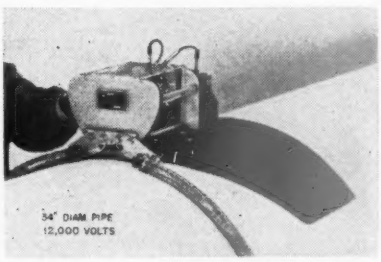
TINKER & RASOR ANNOUNCES A NEW HOLIDAY DETECTOR THAT OPERATES *WITHOUT A GROUND WIRE!*

• With the new Model H-2 Detector there's no trailing ground wire to cause trouble and delay . . . it has been replaced with a "double electrode" (Pats. Pend.) called a "saddle" which fits over the top of the pipe and travels along with the instrument. This combination provides constant inspection voltage on any pipe size under all operating conditions.

The newly designed electrode combination (U. S. Pat. No. 2,629,002) allows the helical spring electrode to be disengaged from operating side when passing over skids. Spring electrode revolves on sealed roller bearings. Provision is made for use of wand with full circle electrode or brush applications.

The Model H-2 Detector is available on a rental, rental-purchase or purchase basis. Write for complete details.

Includes instrument, 2 battery sets, battery charger, "saddle," helical spring electrode, and shipping case. Power input: 6 volt 22 amp.-hr. plastic storage battery. Average input current 3 to 3.3 amperes. Output Voltage: 12,000 to 14,000 on 12" to 30" diam. pipe. Pulse wave form of 7 to 8 micro second crest duration. Pulse rate: 35 to 40 c.p.s.



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Radio Permits Granted to Six Companies by FCC

Construction permits have been issued to six pipe line companies for 10 permanent units and 150 mobile units by the Federal Communications Commission.

Two fixed developmental units near Huffman on 956.1 mc and near Humble on 959.7 mc have been authorized Sun Pipe Line Company, Beaumont, Texas.

Natural Gas Pipeline Company of America, Chicago, Illinois, received authority for four fixed developmental units, two at Aurora, Illinois, on 6585 mc and two at Downers Grove, Illinois, on 6705 mc.

Two fixed relay units near Clinton, Iowa, operating on 48.70 mc were authorized Transcontinental Gas Pipe Line Corporation, Houston, Texas.

A base station at Vinson, Oklahoma, on 33.38 mc was authorized to Continental Pipe Line Company, Ponca City, Oklahoma.

Humble Pipe Line Company, Houston, Texas, received authorization for 150 mobile units in the South and Southwest, to operate on 48.86 mc.

A base station to cover Arizona, New Mexico, West Texas and Colorado, and southern Utah on 48.74 mc was granted El Paso Natural Gas Company, El Paso, Texas.

UCLA Schedules Course On Cathodic Protection

Cathodic protection will be the subject of a three-day corrosion short course to be given at the University of California at Los Angeles, November 16-18. Registration will be limited to 110 persons. It will be directed toward training maintenance and operating personnel in installation and maintenance of cathodic protection systems in the field.

Sessions will last six hours daily and will include the following topics: Basic Electrochemical Principles, Corrosion Circuit Theory, Corrosion Engineering, Instruments and Measuring Techniques, Design and Application of Cathodic Protection, Economics of Cathodic Protection. Meetings will be held at 813 South Hill Street, Los Angeles. P. W. Hill, Signal Oil and Gas Company and N. K. Senatoroff, Southern Counties Gas Company of California, are aiding representatives in setting up the course.

The short course will be followed by the Western Regional Division Conference of National Association of Corrosion Engineers to be held at the Biltmore Hotel in Los Angeles, November 19-20.

Phillips Crude Line Division Receives Safety Merit Award

The crude oil pipe line division of Phillips Pipe Line Company, a subsidiary of Phillips Petroleum Company, has received the National Safety Council Award of Merit for establishing during 1952, disability injury rates significantly lower than its par rates.

Par rates of disability injuries are established by the National Safety Council by combining the oil pipe line industry frequency and severity figures with those of the company for 1950 and 1951.

C. R. Musgrave, vice president of supply and transportation for Phillips, congratulated the crude oil pipe line division employees on their achievement. Ed I. Thompson, Oklahoma City, Oklahoma, is safety director for the division.

Expansion of Gas Industry Outlined in New Brochure

Complete information on the multi-billion dollar expansion of the natural gas industry is now available in the 1953 edition of "Natural Gas Construction Data," a 50-page brochure published by the Gas Appliance Manufacturers Association.

Included in the booklet is detailed information on mileage, line sizes, costs, pipe tonnage, and compressor horsepower, and data on projects authorized, completed or pending before the FPC, during the period July 1, 1945, to January 1, 1953.

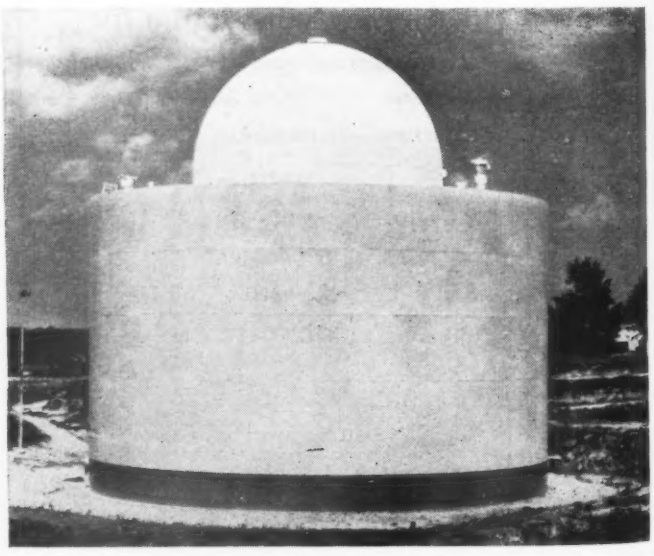
The brochure is intended as a review of recent natural gas pipe line construction to serve the needs of banks, insurance companies, investment houses, and other financial organizations.

Copies of the brochure may be obtained at $2.00 per copy from the Marketing and Statistical Department of the Gas Appliance Manufacturers Association, 60 East 42nd, New York 17, New York.

New Basrah Pipe Line In Iraq Completed

A new pipe line of Basrah Petroleum Company, between the Zubair field in Iraq and the Persian Gulf tanker terminal at Fao, has been completed, reports to American oil companies have indicated.

The 24-in. is 65 miles long, and required more than 17,500 tons of pipe, most of which was produced in Great Britain. The new line supplement an existing 10- and 12-in. line between Zubair and Fao, 64 miles long. Basrah Petroleum is an affiliate of Iraq Petroleum Company.



ALABAMA'S rugged mountains, left, outline this pretzel-like section of pipe being lowered in by a team of side boom tractors on a 24-in. loop being constructed for Southern Natural Gas Company. H. C. Price has contract. At right is an oil storage tank. One might expect this latest type of oil storage tanks to double as a planetarium, with the starry firmament projected against its penthouse dome. Or, with the addition of a powerful telescope, it could serve as an excellent observatory. Actually, the purpose of the dome is to collect vapors which would otherwise escape into the atmosphere through the vents in conventional type roofs. This newest innovation in tank design was erected recently by Chicago Bridge and Iron Company for the Shell Oil Company and situated at its Spartanburg South Carolina, distribution center.

NACE Northeast Region To Meet October 7

The Northeast Regional Conference of the National Association of Corrosion Engineers will be held October 7 in New Haven, Connecticut, at the Hotel Taft. Beginning at 2 p.m. three prominent men in the field of corrosion will present technical papers: Dr. R. B. Hoxeng, U. S. Steel Corporation, Dr. William E. Robertson, Yale University, and Dr. H. R. Copson, International Nickel Company, Inc.

Three National Meetings To Attract Pipeliners

Meetings of three well-known organizations will attract pipeliners during the next month, beginning with the *41st National Safety Congress and Exposition* in Chicago, October 19-23. Of interest to pipe line operating men will be discussions of repair and maintenance of pipe lines, safe methods of purging air from natural gas lines, and a panel discussion on effective safety meetings.

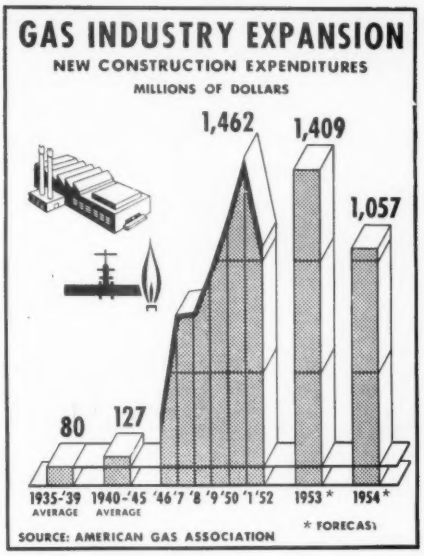
Natural gas pipe line men will journey to St. Louis October 26-28 for the *35th Annual American Gas Association Convention*. Discussions on the agenda of the operating section during the three-day meeting include "Progress in Large Volume Measurement," by F. M. Partridge, Southern California Gas Company; "Overpressure Protection," a panel discussion, W. P. Dick, United Fuel Gas Company, chairman.

"Electronics — A Tool for Communications and Control in the Gas Industry," D. E. Noble, Motorola, Inc.; "Leasing of Automotive and Mobile Equipment," R. O. Babcock, Consolidated Edison Company; "Safe Ways to Perform Pipe Line Repairs," W. H. Krammes, Central Gas Supply; "Hazards of Static Electricity," G. M. Kintz and H. F. Brown, Bureau of Mines.

"Coordination of Corrosion Control," H. L. Hamilton, A. V. Smith Engineering Company; "Acquisition of Underground Storage Rights," Charles W. Studt, Union Gas System; "Gas Turbine Driven Centrifugal Compressors for Gas Transmission," J. F. Eichelmann, El Paso Natural Gas Company; and "Problems of Smaller Gas Companies," a panel discussion, H. Bruce Andersen, Philadelphia Gas Works.

At the annual fall meeting of the *American Institute of Electrical Engineers* in Kansas City, November 2-6, five technical papers on electrical applications in the pipe line industry will be presented.

They are "Selection of Motors and Controls for Pipe Line Pumping Stations," R. J. Osborn, Sinclair Pipe Line Company; "Automatic and Remote Control of Electric Pipe Line Stations," R. S. Cannon, Plantation Pipe Line Company; "Petroleum Microwave Progress 1950-53," E. B. Dunn, Keystone Pipe Line Company; "Application of Outdoor Metalclad Switchgear," E. R. Hoyle, Sinclair; and "Protection of Large Motors," C. R. Olson, Westinghouse Electric Corporation.



IN SEVEN postwar years, expansion of gas industry has averaged nearly a billion dollars per year, or ten times the rate of development in the prewar period. A large part of money spent was used to extend national network of natural gas pipe lines into new areas.

Texas Gas Transmission Completes Expansion Program

Texas Gas Transmission Corporation, Owensboro, Kentucky, has put into service the final 45-mile segment of its 1952-1953 construction program.

The system can now deliver more than 1 billion cubic feet of gas a day through 3236 miles of pipe line.

The final 45-mile segment was composed of two sections—one near Jeffersontown, Kentucky, the other near Slaughters, Kentucky. During 1952 Texas Gas built 363 miles of 26-in. line, but delays in pipe deliveries prevented construction of the final 45 miles before winter weather.

AGA Kit to Explain Many Gas Uses to School Children

A broad educational program designed to acquaint school children with the vital role played by gas in the modern economy has been initiated by the educational service bureau of the American Gas Association.

This is the broadest program of its type ever undertaken by the gas industry. Materials used in the program, from film strips to booklets, were prepared in collaboration with the National Science Teachers Association and with the professional guidance of leading educators. The entire program has been designed strictly from a teacher's viewpoint.

The kit includes a wall chart explaining the flow of gas from the well to the burner, a wall chart showing principal pipe lines in the U. S. and descriptive sheets for the student to take home.

NACE Tulsa Meet Features Pipe Line Corrosion Forum

Thirteen technical papers, a pipe line corrosion forum and an oil and gas transportation round table discussion are included in the technical program prepared for the National Association of Corrosion Engineers' South Central Region 1953 annual meeting at Tulsa, October 7-9 inclusive. The technical papers cover petroleum inhibitors, hydrogen sulfide corrosion mechanism, cathodic protection of underground pipe lines, three papers on corrosion in processing plants and others. Technical committees will meet Wednesday, October 7.

The tentative schedule includes:

Pipe Line Corrosion Symposium

Thursday, October 8

9-12 noon — Pipe Line Corrosion Forum.

9-9:40 a.m.—Cathodic Protection of Bare Pipe Lines in High Resistance Soils by R. C. Martin, Plantation Pipe Line Company, Atlanta, Georgia.

9:40-10:20 a.m.—Economics of Pipe Line Corrosion Mitigation by L. O. Sharpe, Humble Pipe Line Company, Houston.

10:20-11:00 a.m.—Cathodic Protection of Plant Yards with Distributed Anode Systems by P. J. Whitley, Jr., Tennessee Gas Transmission Company, Houston.

11:00-12:00 noon—Discussions.

Thursday, October 8—Afternoon

2:00-2:40 p.m.—Paper, title unavailable.

2:40-3:20 p.m.—Paper by Art Erickson, People's Natural Gas Company, Pittsburgh, Pennsylvania.

3:20 p.m.—Discussions.

Friday, October 9

2:00-4:00 p.m.—Oil and Gas Transportation Round Table.

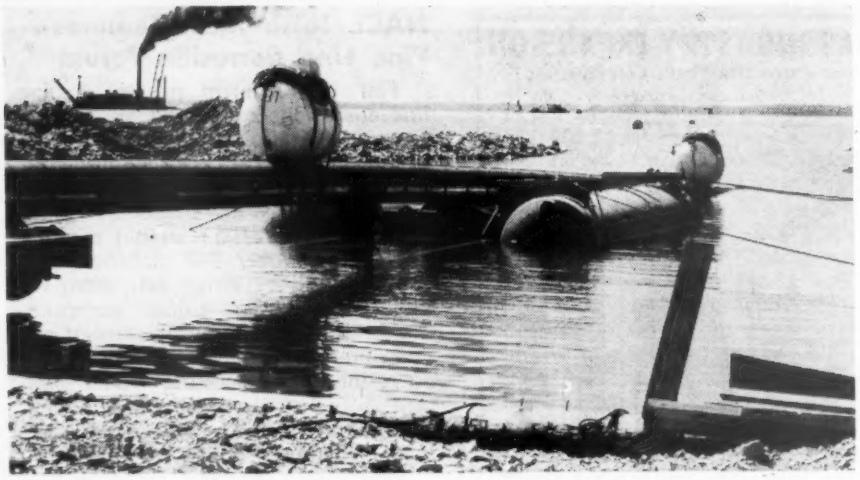
FPC Denies Separate Issue Request by Northern Natural

A move by Northern Natural Gas Company, Omaha, Nebraska, to omit intermediate decision procedure on various phases of application proceedings on the building of pipe line facilities to transport an additional 300 million cu ft of gas to midwestern customers has been denied by the FPC.

Northern Natural had asked that issues in an application approved last spring, dealing with construction during the first 12 months of a two-year project, be separated from the current hearings. During the first year phase, approved plans call for 259 miles of 24- and 30-in. line and addition of 50,400 hp in compressor facilities.

The final 12 months phase, now being considered by the FPC, deals with construction of 204 miles of 24-, 26-, and 30-in line and additional 22,800 hp in compressor capacity.

The earlier ruling by the FPC on the first phase authorized construction but not operation of the facilities. Decision on the second phase must be reached before operation of the first year's construction can start.



FIRST SECTION, top, of pipe to start across Straits. Buoys rode pipe at regular intervals to keep it from sinking immediately to bottom. Parts of pipe were submerged to a depth of 243 ft before resting on bottom.

AS WOULD BE EXPECTED, center, on any 635-mile trenching job, the Lakehead pipe line encountered considerable rocky terrain along its route.

A SECTION of Lakehead pipe line, bottom, after it has emerged from the Straits of Mackinac and moves westward through Upper Michigan swamplands toward Superior, Wisconsin. Here welders working near Engadine, Michigan, use wooden platforms to keep from sinking knee deep into water-soaked terrain.

Rocks, Swamps, Water Mark Lakehead Pipe Line Project

Men and machines have been working day and night in Northern Michigan to beat the early winter deadline set for the completion of one of the longest and largest crude oil pipe lines ever to be constructed.

During the summer, the 30-in. pipe, which was being laid between Sarnia, Ontario and Superior, Wisconsin, for the Lakehead Pipeline Company, was being inched through both the lower and upper peninsulas of Michigan to the Straits of Mackinac. There it was divided into two 20-in. sections to make one of the longest, deepest and most spectacular water crossings in pipe line history.

Oklahoma Natural Converts Sayre Field to Storage Use

Oklahoma Natural Gas Company, Tulsa, has received approval from the Oklahoma Corporation Commission to convert the old Sayre gas field of Beckham County, Oklahoma, to underground storage for gas.

ONG engineers have already started remedial work on wells to be used for injection and are plugging a number of the depleted producers.

Plans call for injection of 20,000,000 cu ft of gas daily into the reservoir when connecting lines and compressors have been installed.

AGA Safety Award Given Pan American Gas Company

Pan American Gas Company, Houston, recently received from the Accident Prevention Committee of the American Gas Association an award for outstanding accident prevention work.

These awards are made each year by the trade association to companies who reduce the frequency of accidents 25 per cent or more during the previous year. The Pan American Gas Company accomplished this reduction during the year 1952 as compared with 1951.

Italian Gas Line Expansion

Approximately 70 additional Italian cities may receive natural gas service in the near future under a plan proposed by officials of Milan Province.

The program calls for the construction of an additional 170 miles of line at an expense of 3.5 billion lire. Another proposed line would tie-in two gas wells with a combined daily production of 1,400,000 cu ft that were recently developed in Catania Province.

Cities Service Constructing Two Products Line Terminals

Cities Service Oil Company has begun construction of two products line terminals, one near Detroit, Michigan, and another at Toledo, Ohio. The Toledo terminal will be situated on the Maumee River and will also serve as a marine terminal.

XUM

Advancing An Empire

In British Columbia and the Pacific Northwest, October 15 is a red letter day. For that date—3 months ahead of schedule—marks completion of the TRANS MOUNTAIN OIL PIPE LINE, its first direct link with a major oil producing area. Together with the expansion of regional refining facilities, TRANS MOUNTAIN already is giving tremendous impetus to industrial development.

This 718-mile oil artery across the Rocky Mountains from Edmonton, Alberta, to Vancouver, British Columbia, opens with a capacity of 120,000 barrels per day. Early in 1954 its capacity will be increased to 150,000 b.p.d. and ultimately to more than 300,000—anticipating the growth of the great Evergreen Empire.

TRANS MOUNTAIN was designed and built under the engineering management of Canadian Bechtel Limited, Agent for the owner, Trans Mountain Oil Pipe Line Company.

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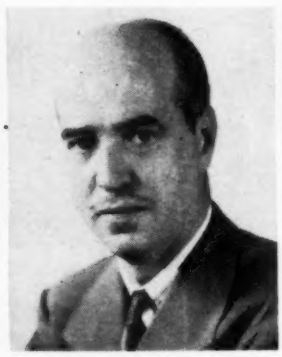
BUILDERS FOR INDUSTRY

Pipe Line Personals

H. C. Bloomfield



J. McGarrie

E. D. Dickson

H. C. Bloomfield, former assistant chief accountant, and **J. McGarrie,** former manager, methods and control, have both been made assistant comptrollers, and **E. D. Dickson,** former assistant chief accountant, is now manager, methods and control, in the accounting department of Interstate Oil Pipe Line Company's Shreveport, Louisiana, general offices.

Bloomfield was born in Canton, Ohio, received his accounting training at Louisiana State University, and in 1922 was employed by the Standard Oil Company of Louisiana in the pipe line department. In succeeding years he served in a variety of accounting positions, first in the Baton Rouge and then in the Shreveport offices of Standard of Louisiana. In 1945, after Interstate acquired Standard of Louisiana's pipe line properties, he transferred to Tulsa, Oklahoma, and in 1946 was named assistant chief accountant of Interstate's Northern division. He returned to Shreveport in 1951 as assistant chief accountant in Interstate's consolidated organization.

McGarrie, born in Glasgow, Scotland, was reared at Boonton, New Jersey, where he attended high school. He received his training in business law and accounting at Pace College, New York. In 1925, he was employed by Standard Oil Company (New Jersey). He joined Interstate in Tulsa, Oklahoma, in February, 1946, and a year later was made assistant comptroller. With the consolidation of Interstate's Tulsa and Shreveport offices in Shreveport, he was named manager of methods and control.

Dickson was born in Red Cloud, Nebraska, and received his BS degree in business administration from the University of Nebraska. After seven years in the St. Louis, Missouri, offices of Price, Waterhouse and Company, he was employed in the pipe line department of Standard Oil Company of Louisiana in August, 1935. In January, 1936, he was made assistant chief accountant and served in that capacity with the successor organizations until the present time.

Victor C. Fairless has been appointed general manager of Sun-Canadian Pipe Line Company, Ltd., and will have offices in the vicinity of Waterdown, near Hamilton, Ontario.

Fairless was formerly assistant division superintendent of the eastern division of Sun Pipe Line Company's product lines department at Coatesville, Pennsylvania. He was employed August, 1930, by Susquehanna Pipe Line Company, a wholly-owned subsidiary of Sun Oil Company which was later merged with the Sun Pipe Line Company.

A. B. Johnson, chief engineer of The Ohio Oil Company's pipe line department, retired September 1 after a 36-year career during which he performed engineering on every major line laid by Ohio Oil in that period. **C. F. Firmin,** assistant chief engineer, will succeed Johnson as chief engineer, it was announced by O. F. Moore, manager of pipe lines.

Johnson, a civil engineering graduate of the University of Minnesota, joined Ohio Oil's subsidiary, The Illinois Pipe Line Company in 1918 as assistant chief engineer at Casper, Wyoming. He advanced in 1921 to chief engineer in charge of location and design of lines in Wyoming, Montana, New Mexico, and Texas. He was promoted to assistant general superintendent of lines at Del Rio, Texas, in 1933. Two years later he moved to Findlay, Ohio, as chief engineer of The Illinois Pipe Line Company. With the dissolution of that company in 1942, he became chief engineer of Ohio Oil's pipe line department.

Firmin, who received his degree in mechanical engineering at Case Institute of Technology, began his career with Ohio Oil in the refinery engineering department at Findlay in 1933. The following year he was transferred to marketing engineering, and in 1938 moved to Robinson, Illinois, in refinery engineering work. He returned to Findlay in 1943 as engineer in the pipe line department, advancing to assistant chief engineer in 1949.

C. D. Rogers

L. C. Benne

H. O. Porter

Clint D. Rogers, former superintendent of operations, has been named manager of operations for Cities Service Gas Company and will move from Wichita, Kansas, to Oklahoma City, Oklahoma. **L. C. Benne,** former assistant superintendent of operations, has been advanced to superintendent of operations and will remain in Wichita, Kansas. **H. O. Porter,** former assistant superintendent of gas transportation, has been promoted to assistant superintendent of operations.

Rogers, a native of Vinita, Oklahoma, has been connected with the company since 1927. He graduated from Oklahoma Agricultural and Mechanical College with a BS degree in chemical engineering and enrolled in the Cities Service junior engineering course in 1927. He was promoted to superintendent of operations in 1929 and held that position until his present appointment as manager of operations.

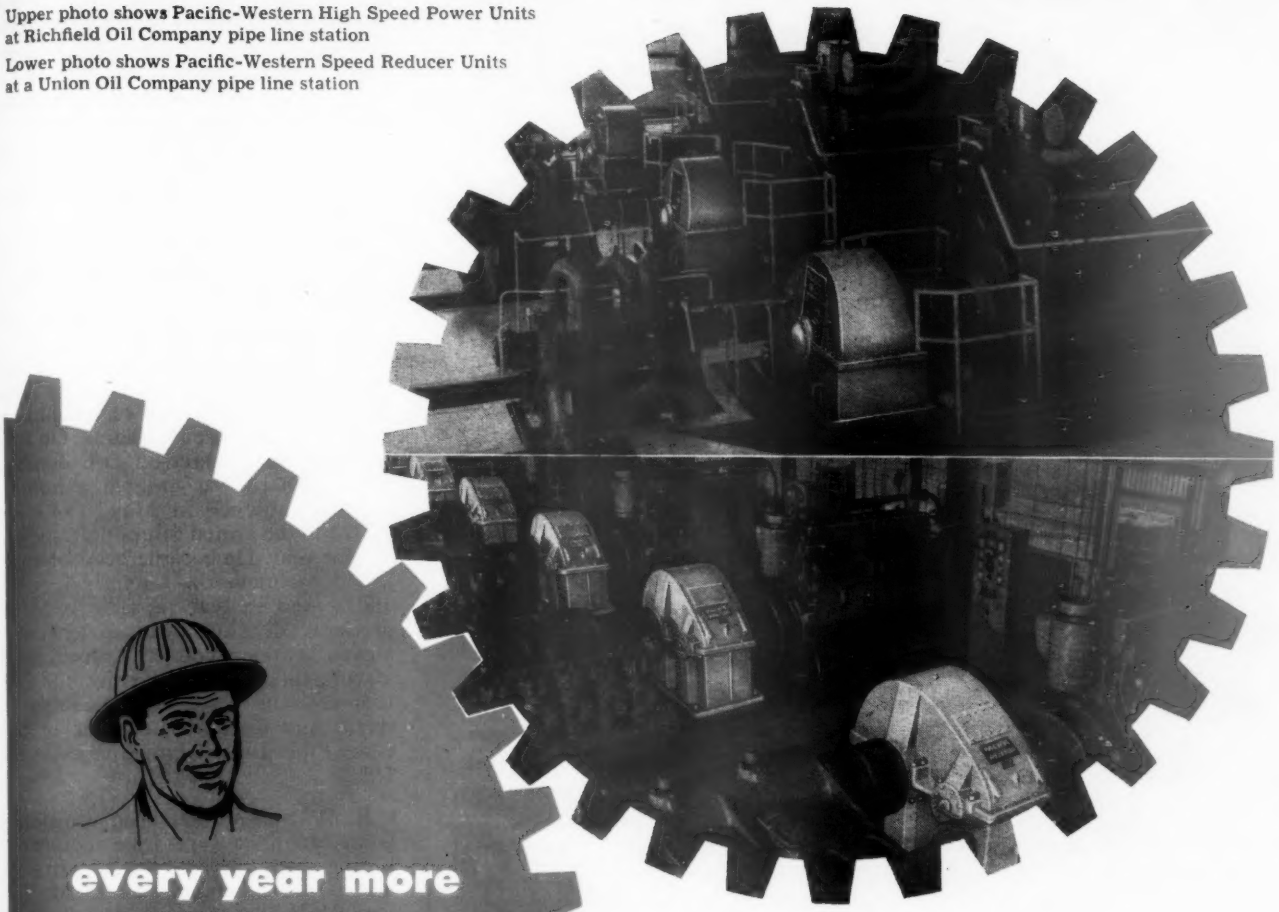
Benne was born at Washington, Kansas, and graduated from Kansas State College with a BS degree in civil engineering. He was formerly associated with Sinclair Pipeline Company; Kansas State Highway Department; and Missouri-Kansas-Texas Railroad until 1928 when he was employed by Cities Service Gas as a junior engineer. He was promoted to assistant superintendent of operations in 1931.

Porter, a native of Ft. Collins, Colorado, graduated from Colorado A & M College with a BS degree in mechanical engineering. He joined the company as a junior engineer in 1927 and served as superintendent in both compressor and pipe line departments until 1949 when he was appointed assistant superintendent of gas transportation.

XUM

Upper photo shows Pacific-Western High Speed Power Units at Richfield Oil Company pipe line station

Lower photo shows Pacific-Western Speed Reducer Units at a Union Oil Company pipe line station



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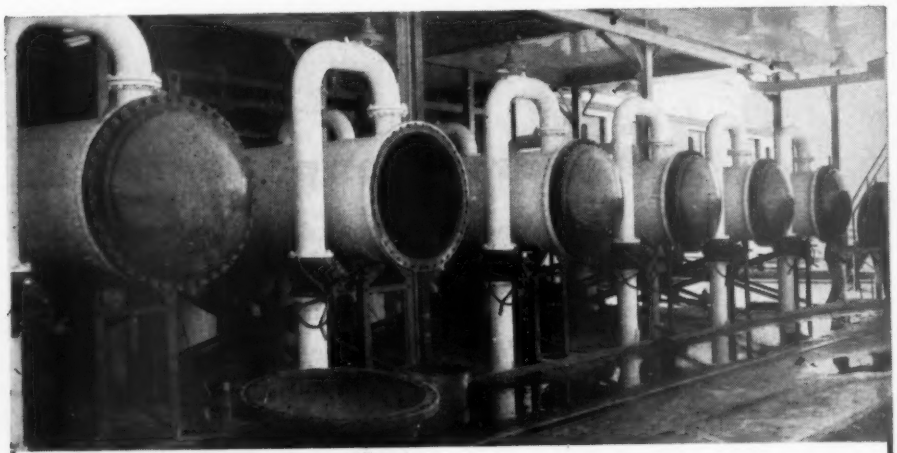

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PIPE LINE PERSONALS

▸ **J. H. Renard,** assistant secretary and assistant treasurer of Sinclair Pipe Line Company has been promoted to position of administrative assistant in the executive department of the company. Renard was transferred to this capacity in conjunction with the reorganization and expansion of the executive staff and will assist **William H. Morris,** president.

Renard was born at Mechanicsburg, Pennsylvania, graduated from Mechanicsburg High School, and later graduated from Central Pennsylvania College of Business in Harrisburg, Pennsylvania. In August, 1943 he joined Sinclair Refining Company—Pipe Line Department (Products Division) at Mechanicsburg, Pennsylvania. On June 1, 1944 was transferred to Columbus, Ohio. Renard was granted a military leave of absence in May, 1945 and served in the armed forces until the end of that year. He became head of treasury department on January 1, 1947, and served in that capacity until the products division headquarters were moved to Independence, Kansas. After serving in clerical capacities for over four years he was elected assistant secretary and assistant treasurer of Sinclair Pipe Line Company in April, 1952.

▸ **R. W. Stewart** has been transferred from Magnolia Pipe Line Company's Luling district as district superintendent, to the Midland district. **H. M. Van-Buskirk** has been transferred from the Midland district to district superintendent of the Luling district. **L. A. Foy** has been promoted to chief gager of the western pipe line division with headquarters at Midland, Texas. **John R. Dean** has been named chief gager of Magnolia's north Texas and Olden districts with headquarters at Wichita Falls, Texas. **Arnold Balke** has been transferred to Midland, Texas, where he will be gager foreman in the Pegasus area. **K. B. Snider** has been named gager foreman in the Premont area of the Alice district.

▸ **Harold F. Moses** has been elected president of Interstate Natural Gas Company of Monroe, Louisiana, and general manager of Olin Industries' newly created oil and gas division.

Moses has resigned as director and vice president in charge of exploration and research of Carter Oil Company of Tulsa, Oklahoma, to accept his new position with Olin.

He has been closely associated with the oil and gas industry since his graduation from the University of Chicago in 1923. After work with the U. S. Geological Survey, he taught geology at the University of Oklahoma. In 1925 he joined Henry L. Doherty and Company, New York City, and for nine years engaged in geological exploration in South and Central America culminating in 1933 as general manager of their Mexican operations. The following year he accepted an assignment with the Turkish government to review that country's petroleum resources.

XUM

SECTIONS OF 26-INCH PIPE ARE JOINED TOGETHER NEAR OWENSBORO, KENTUCKY, AS H. C. PRICE CO. COMPLETES 363-MILE LOOPING PROJECT FOR THE TEXAS GAS TRANSMISSION CORPORATION.

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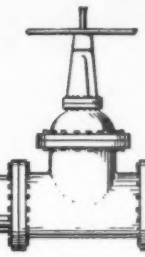
PIPE LINE PROJECTS



Army Asking Bids For Alaskan Products Line

Bid opening on the 615-mile Haines to Fairbanks, Alaska, products pipe line, which has been advertised since August 29, will be held October 14 by the office of the Alaska District Corps of Engineers.

The project, which will be interior Alaska's supply line for petroleum products for planes, transports and vehicles at Alaskan military installations, will follow a general route paralleling the Alaskan highways, by way of the Haines cut-off and travel through 283 miles of Western Canada.

Involved in the construction are 615 miles of 8⅝-in. pipe, a terminal wharf at Haines, five pumping stations with all utilities, four stations with supporting facilities, terminal facilities near Fairbanks, two intermediate take-off facilities, and two tank farms.

Cost of the completed line is estimated at $40,000,000. A 50-ft right-of-way will be provided on the route, which will cross mountains, rivers, canyons and much open land.

A major construction feat will be the crossing of Kluane lake, north of Whitehorse in Canada's Yukon Territory, where the line will make a 8½-mile, 290-ft deep crossing.

Port facilities at Haines will be used to supply materials for the southeastern section of the construction project. Seward and Valdez port facilities will be utilized later as the work moves northward. Some 42,000 tons of pipe will be needed for the line.

Biggest Inch Extension Underway in California

Plans for construction of 73 miles of 30-in. natural gas pipe line in Riverside County, California, to parallel the original "Biggest Inch" pipe line, have been completed with awarding of a contract for the work to River Construction Company of Fort Worth, Texas, according to F. M. Banks, president of Southern California Gas Company.

Work on the new pipe line, which will cost approximately $5,300,000, is underway. The new loop pipe line is expected to in operation by January 31, 1954.

The new addition to the 30-in. natural gas pipe line, jointly owned by the Southern California and Southern Counties Gas Companies, is part of a $210 million program approved in July by the Federal Power Commission. Cost of the new facilities to move the additional gas to California markets total $175 million for the El Paso Natural Gas Company, $7,500,000 for the two Southern California gas companies, and $26,700,000 for the Pacific Gas and Electric Company of San Francisco.

Work on the new 30-in. loop will be divided into three sections. The first segment will be the laying of 37.5 miles paralleling the present line westerly from Blythe. The other two sections will include 35.5 miles of pipe between Whitewater and a point 5.5 miles east of the Cactus City booster station. A 14-mile section, generally paralleling the Texas-California Pipeline, was installed last year.

PG&E Requests FPC Okay On 11-Mile Gas Line

Pacific Gas and Electric Company, of San Francisco, California, has filed application with the FPC requesting authority to construct a total of about 11 miles of natural gas pipe line in the Pittsburg, California, area.

Total estimated construction cost of the project is $992,800. The company plans to build about 10½ miles of 24-in. pipe line from its Antioch control station to its steam electric plant, now under construction at Pittsburg, and approximately 2500 ft of 24-in. pipe line to serve as a tie main between the western end of the 10½ miles of line and Standard Pacific Gas Line Incorporated's pipe line system at Stoneman Junction.

The 10½ miles of proposed line is designed to deliver 6,500,000 cu ft of natural gas per hour to the Pittsburg steam electric plant. The 2500-ft tie main would be used as an alternative means of routing gas between the Antioch control station and Stoneman Junction, thus helping to assure uninterrupted service to Standard Pacific's system.

Carter to Build Terminal

Plans for construction of a 11,800,000 gallon capacity pipe line terminal in Spokane have been announced by The Carter Oil Company.

The terminal, from which products will be dispatched to Spokane retail outlets as well as to dealers in Washington, Idaho and northwestern Montana, will have six storage tanks and a bulk plant office. The terminal will handle premium and regular grades of gasolines and light heating oils and diesel fuels.

The Spokane terminal, will be the largest of four planned by Carter along the Yellowstone pipe line. A terminal at Helena will have capacity of 4,800,000 gallons, one at Missoula of 3,900,000 gallons, and one at Bozeman 3,700,000 gallons. Each terminal will serve a wide adjacent area.

Bombay Harbor Line Project Awarded Collins Specialists

Collins Construction Company, Victoria, Texas, has completed negotiations to lay 84,000-ft of submarine pipe line in the harbor at Bombay, India. These various lines will be used to carry crude from tankers at terminal piers off Butchers Island and to return finished products from two refineries now nearing completion on the outskirts of Bombay.

Collins will furnish a complete spread of pipe line equipment. A 2500-ft launchway of the type used successfully on the Straits of Mackinac crossing for Lakehead Pipe Line Company will be included. Plans also call for Collins' patented pipe-launcher and three jet trenching machines.

Prime contractors are Merritt-Chapman and Scott of India, and Hindustan Construction Company, Ltd., in a joint venture. Sir Bruce White, Wolfebarry and Partners of No. 1 Lygon Place, London, England, are the project engineers. Collins will loan submarine pipe line specialists to the prime contractors.

Badger Pipe Line Company To Build 215-Mile System

Construction of a $15,000,000 products pipe line system from Chicago to Madison, Wisconsin, will be started in the spring by Badger Pipe Line Company, C. S. Mitchell of Bartlesville, Oklahoma, president of Cities Service Pipe Line Company, and of the recently-incorporated Badger Pipe Line Company has announced.

The 215-mile system, which will give Wisconsin its first products pipe line, will be built and operated by Cities Service Pipe Line Company. It will be owned jointly by Cities Service Oil Company, Sinclair Pipe Line Company, The Pure Oil Company, and The Texas Company.

The line, scheduled to be put into operation late in 1954, will originate in the East Chicago, Indiana, area and will serve metropolitan Chicago, Rockford, Illinois, and Madison, Wisconsin, areas.

The system will consist of 197 miles of 12-in. and 18 miles of 10-in. line, with three pump stations and an initial capacity of about 65,000 bbl daily.

Badger Pipe Line Company, also will purchase an existing 8-in. products line extending northward from Peru, Illinois, a distance of 67 miles, to Rockford.

Distribution terminals will be located at Harlem Avenue (Southwest Chicago) and Des Plaines, Illinois, Rockford, and Madison.

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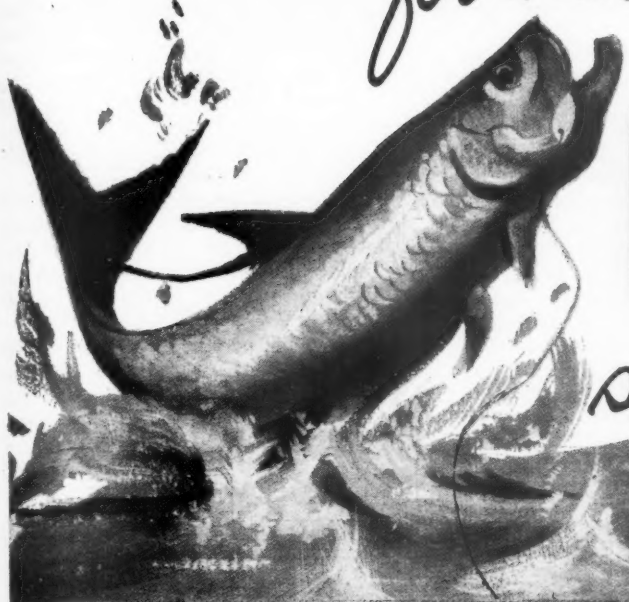

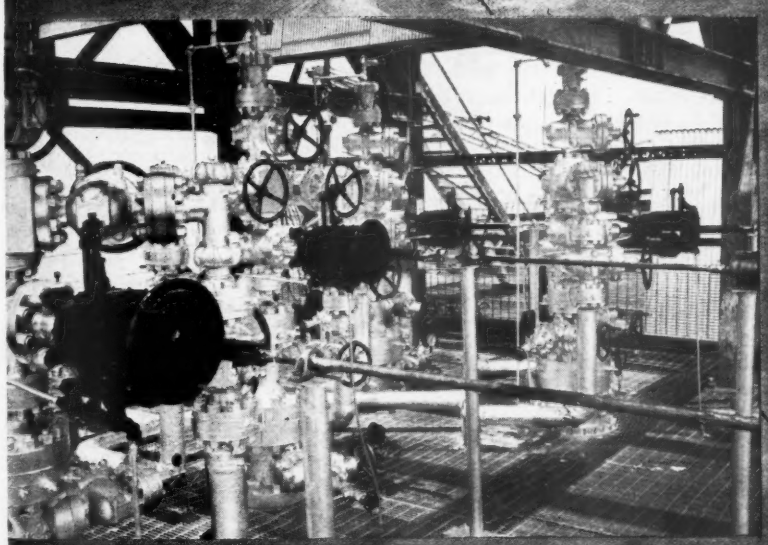

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FPC Okays Tennessee Plan To Export Gas to Canada

The FPC has authorized Tennessee Gas Transmission Corporation, of Houston, Texas, and Niagara Gas Transmission, Ltd., of Toronto, Canada, to export natural gas from the United States for ultimate consumption in the Toronto, Ontario, market area.

The FPC order authorizes a transportation arrangement whereby Tennessee will transport natural gas from the southwestern United States for delivery to Iroquois Gas Corporation, of Buffalo, New York, at points in Pennsylvania and New York.

Under the export plan, Niagara will purchase natural gas in the Gulf Coast area of the southwestern United States for transportation by Tennessee to a point on the U.S.-Canadian boundary near Niagara Falls, New York. The gas will there be delivered to Niagara which will transport it to the Toronto area where it will be resold to Consumers Gas Company for resale for ultimate public consumption. Niagara is owned by Tennessee and Consumers.

The Commission authorized Tennessee to deliver a maximum of 22.6 billion cu ft of natural gas annually to Niagara, at a rate of not more than 115,600,000 cu ft per day. Average deliveries will be approximately 62,000,000 cu ft daily. Tennessee will transport a maximum of 49,728,000 cu ft per day for Iroquois.

Tennessee will construct a total of approximately 904 miles of pipe line and 38,800 hp in compressor capacity to increase its system capacity for the transportation of the additional gas. The construction will bring the total capacity of Tennessee's system up to 1,728,390,000 cu ft per day, an increase of 111,690,000 cu ft over the presently authorized capacity. In addition, Tennessee will be able to deliver an additional maximum of 210,936,000 cu ft of gas daily from its Hebron, Pennsylvania, storage area. Total estimated cost of the Tennessee project is $91,718,000.

Tennessee's construction program includes 571 miles of 30-in. main line from its Station No. 507 near Kinder, Louisiana, to its Station No. 87 near Portland, Tennessee; 67 miles of 30-in. loop lines in Texas and Louisiana; 63 miles of 26-in. loop lines in Ohio and Pennsylvania; 45 miles of 20-in. pipe line extending from Buffalo to the U. S.-Canadian border; 58 miles of 20-in. line in Louisiana from Tennessee's present system on the Gulf Coast to its Station No. 507; and 100 miles of miscellaneous laterals in Texas. Of the additional compressor capacity, 17,520 hp will be installed in existing stations and 21,280 hp will be installed in three new stations located in Mississippi, Kentucky, and New York.

Tennessee will transport 61,914,000 cu ft of gas per day for Niagara from the Southwest. When Niagara's daily requirements drop below this full amount, the difference will be stored by Tennessee for later delivery to Niagara. Thus, when peak day deliveries reach the maximum amount, the 61,914,000 cu ft will be delivered directly with the remainder coming from storage.

The gas to be transported for Iroquois will be resold by that company and two of its affiliates, United Natural Gas Company, of Oil City, Pennsylvania, and Pennsylvania Gas Company of Warren, Pennsylvania. Approximately half of the gas will be delivered by Tennessee to Iroquois in New York and half to the two affiliates in Pennsylvania.

The Commission's authorization contains several conditions, including a requirement that Tennessee shall file an application by next January 1 for authority to dispose of the unallocated capacity of approximately 131,570,000 cu ft of gas per day which it will have upon completion of all its authorized facilities.

Gulf Surveying Route for New Mexico Line Extension

Gulf Refining Company has commenced surveys on a crude oil pipe line extension in New Mexico. The new construction is to be a 23.4-mile northward extension of a 10-in. crude line from the present point of origin of Gulf's pipe line at Lea Station in Lea County, New Mexico, and will branch in a wye at the northern end of the 10-in. extension into two 8-in. lines, one of which will extend 23 miles westerly to the Anderson Ranch field, and the other of which will extend 16.9 miles northeasterly to the Denton field.

Construction of this extension will be expedited and it is expected that the line will be completed and in service by January 1, 1954.

Work on NATO's $100,000,000 Products Line Soon Underway

Work on the North Atlantic Treaty Organization's 1920-mile products pipe line system, ranging from 4-in. to 10-in. in size, is expected to get underway shortly, NATO officials have indicated.

The $100,000,000 system, still classified as "secret," will be built in France, Belgium, Holland, West Germany, Italy, Greece, Norway, Denmark, and Turkey. The line will be used to move aviation gasoline and other petroleum products to military bases in the NATO member countries.

A contract for management of the construction and operation of the system has been arranged by NATO with the Foster Wheeler Corporation of New York City.

The network will tie into an 8-in. and 10-in. line being built by the United States Army between St. Nazaire and Metz.

Foster Wheeler Francaise will have charge of construction of the network with each country involved planning its own route and doing the actual construction. Work is expected to be completed by late 1955.

$4,000,000 Crude Line Planned by Pasotex

Definite plans to build a 146-mile, 10-in. crude line to serve as a market outlet for the Scurry County reef area have been announced by Pasotex Pipeline Company, El Paso, Texas. The $4,000,000 line will extend from near Snyder westward to Wink in Winkler County where it will connect with Pasotex's trunk carrier to El Paso.

Initial capacity of the new line will be 22,000 bbl per day with one pump station to be built at the eastern terminus. Addition of another pump station would increase capacity to 35,000 bbl per day.

Work on the line is to begin soon and the project is scheduled for completion in early 1954. The line will move sweet crude to El Paso for processing in Standard Oil Company of Texas' refinery. Standard of Texas and Pasotex are affiliate companies.

Production in the Scurry area by Standard of Texas is presently 27,000 bbl per day, and most of it now moves east and northeast by other lines.

Mexico-U. S. Line

Construction of the first pipe line to be laid for the purpose of importing crude oil into the United States from Mexico has been begun by Gabriel Oil Company.

The new 4-in. line, 15 miles in length, will be built between Reynosa, Mexico, and McAllen, Texas, connecting operations of Petroleos Mexicanos with the Rincon Pipe Line System, operated by Continental Oil Company. The new line will have a capacity of 8000 bbl per day.

Equitable Gas to Operate West Virginia Storage Field

The FPC has authorized Equitable Gas Company, of Pittsburgh, Pennsylvania, to operate a natural gas storage field in Wetzel and Marion counties, West Virginia, and to construct pipe line facilities in connection with the activation of the pool for storage purposes.

The company plans to activate the Logansport pool by constructing a 1320-hp compressor station, nine miles of 12-in. pipe line, and about 1.8 miles of 6-in. and 0.7 miles of 8-in. well-connecting pipe line. The company also will recondition nine existing wells, including four to be acquired, during 1953. There are 25 wells now located in the Logansport pool, of which 21 will be operated initially with the remaining four to be placed in operation after testing.

Construction of the proposed facilities is expected to provide a capacity of 3.023 billion cu ft of natural gas with a maximum daily deliverability from storage of approximately 59,500,000 cu ft. The project is designed to enable Equitable to meet its estimated storage requirements through 1957.

Total estimated cost of the storage project is $2,217,400.

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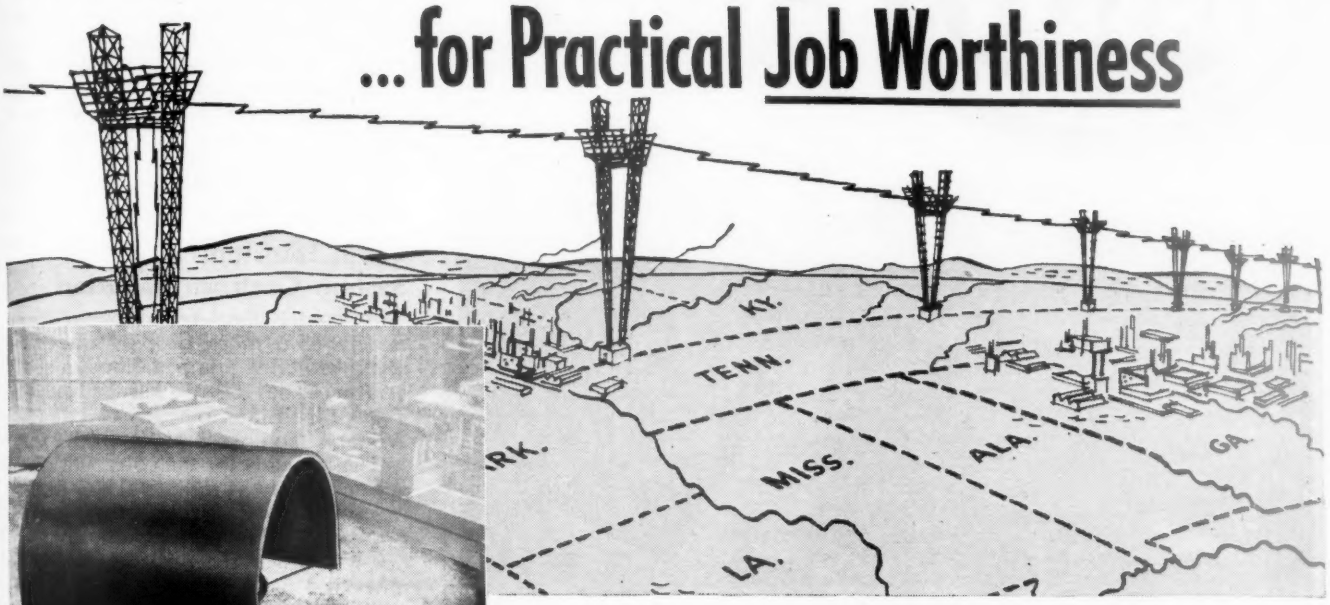

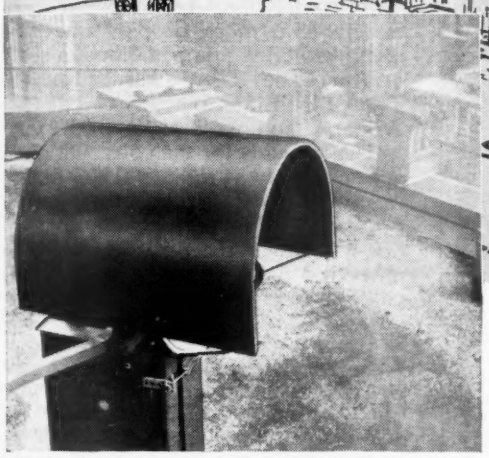

Operating on a round-the-clock basis for Texas-Illinois Natural Gas Pipeline Co., this Chicago roof-top installation terminates a thousand-mile Motorola Microwave system that provides the ultimate in industrial communications.

Simultaneous transmission of numerous telemetering and voice signals over one radio-frequency carrier allows positive, instantaneous control over widely separated, remote system facilities.

Successful Motorola Engineering has produced the kind of thoroughly dependable Microwave that Industry and Safety Services are adopting with justified confidence.

Motorola systems are in and working! Thousands of miles of multi-channel Motorola Microwave systems, with hundreds of operating stations, have been designed, installed and are in daily operation for many pipeline companies, civil agencies and airlines. Eight Motorola systems have been operating 24 hours daily, non-stop, for over four years! With additional major systems under construction, Motorola continues to add to the extensive background of field and engineering experience that has brought outstanding industry acceptance. Below is a partial list of systems installed and operating, and those under construction (*) or under contract (**):

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Brazos River Electric Transmission Cooperative, Waco, Tex.
Illinois Power Co., Decatur, Ill.
Central Illinois Public Service Co., Springfield, Ill.
Pan American Pipeline Co., Houston, Tex.
Shell Pipeline Co., Houston, Tex.
Panhandle Eastern Pipeline Co., Kansas City, Kans.
Mid-Valley Pipeline Co., Longview, Tex.
Southern Counties Gas Co., Los Angeles, Calif.
*La Fourche Telephone Co., Golden Meadow, La.
*Greenwood Telephone Co., Greenwood, So. Car.
*Santa Fe Telephone Co., Melrose, Fla.
*Middle South Utilities, Pine Bluff, Ark.
*Bonneville Power Administration, Chehalis, Wash.
*Sinclair Pipeline Co., Independence, Kans.
*Freeport Sulfur Co., New Orleans, La.
*Texas Electric Co., Ft. Worth, Tex.
**West Coast Telephone Co., Everett, Wash.
U. S. Atomic Energy Commission
**Dayton Power & Light Co., Dayton, O.
**Southern California Edison Co., Los Angeles, Calif.

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PROJECTS

Short Gas Line Planned By Indiana Company

Plans to construct a 35-mile, 10¾-in. gas line to supply 12 communities in Indiana with natural gas have been announced by Northern Indiana Fuel and Light Company, Auburn, Indiana.

The company has applied to the FPC for permission to construct a line from the Panhandle Eastern system at Edgerton, Indiana, to Northern Indiana's system at Auburn. The company also seeks permission to buy nearly 2,000,000 cu ft daily.

South Louisiana Gathering System Contract Awarded

A contract to construct approximately 65.6 miles of pipe lines and seven gathering pump stations in south Louisiana has been awarded by The Texas Pipe Line Company to Panama-Williams Company, Houston, Texas.

The job calls for the construction of approximately 34 miles of 12¾-in. line from Golden Meadow to Houma, Louisiana, together with 26 miles of 8⅝-in., three miles of 6⅝-in. and 2.6 miles of 4½-in. gathering lines in Leeville, Bay De Chene and Golden Meadow pools.

New Wyoming Line Proposed To Move Crude Supplies

A new 6-in. or 8-in. pipe line to serve producing areas in northern Johnson County, Wyoming, has been proposed by the Powder River Pipeline Company, a group of Wyoming businessmen.

The group plans a $500,000 line that would include pickup facilities for the North Fork and Dougout Creek areas of Johnson County. An alternate proposal includes delivery of crude to Casper if facilities now operating from Salt Creek to Casper prove inadequate to handle the line's approximate daily capacity of 3500 bbl per day.

Oklahoma-Mississippi Products Line Planned By Sunray

The Oklahoma-Mississippi River Products Pipe Line, Inc., is being organized to construct and operate a 10-in. products pipe line from Oklahoma to the Mississippi River, Sunray Oil Corporation has announced.

Sunray officials are directing preliminary organization of the new corporation, and negotiations are under way with pipe line construction contractors and others concerned with plans for the new pipe line. Cost of the line is estimated at $15,000,000.

The new 475-mile line as proposed will have its western terminus at Sunray Village (Duncan), Oklahoma, where Sunray operates a catalytic cracking refinery, and will probably be routed across south central Oklahoma, entering Arkansas in the vicinity of Fort Smith, passing nearby to Conway, north of Little Rock, with eastern terminus in the area of Memphis, Tennessee.

WITH THE PIPE LINE CONTRACTORS

Anderson Brothers Corporation, P. O. Box 2591, Houston, Texas, has three spreads in operation on 180 miles of 30-in. line being laid between the Michigan-Wisconsin state line to Cooks, Michigan, for Lakehead Pipe Line Company. K. B. Killingsworth is in charge of the section from the state line starting point to Crystal Falls, Michigan. Another section from Crystal Falls to Cooks is being supervised by Aldress Kilgore. Earl Saulsmann is directing the other spread.

Construction of 82 miles of 14-in. between Charlotte and Greensboro, North Carolina for Plantation Pipe Line Company is progressing. Dick Bond is assistant superintendent with headquarters at Concord, North Carolina.

Work has begun on 117 miles of 16-in. line from east side of Kalamazoo River, Michigan, to Wayne County, Michigan, for Wolverine Pipe Line Company. Dick Leonard is superintendent and W. W. Kirk office manager.

Company is working on approximately 70 miles of 3-, 4-, 12-, and 24-in. natural gas line for Gulf Interstate Gas Company in Louisiana. Glenn Allman is superintendent, with headquarters at Abbeville, Louisiana.

Company also has approximately 12 miles of 6-in. at Venice, Louisiana, for Freeport Sulphur Pipe Line Company.

Anderson International Constructors, Inc., Rawleigh Building, Edmonton, Alberta, Canada, is completing work for Trans Mountain Pipe Line.

Work has also begun on 135 miles of 24-in. for Interprovincial Pipe Line Company, which will be laid in four loops in Saskatchewan and Manitoba. One spread is in operation in Manitoba with Dick Jernigan in charge.

Associated Pipe Line Contractors, Inc., Houston, Texas, is working on 200 miles of 10-in. line from Bismark to Fargo, North Dakota, for Standard Oil Company. Jim Ed Andrews is superintendent and Buck Johnson office manager at the Bismark field office.

Company is also working on 40 miles of 14-in. pipe line for Texas Company in Louisiana, from Paradise to Golden Meadow. Willie Briley is superintendent and R. N. Cain office manager.

Banister Construction, Ltd., 609 Northern Hardware Building, Edmonton, Alberta, Canada, has contract for 27 miles 6- to 16-in. line for Socony-vacuum between Fosterton field and a railway connection. J. Flavin is superintendent and Ray Olfield spread boss.

Company also has 28 miles 1-through 6-in. for Alberta Consolidated Gas between Hanna and Hanna field, 11 miles of 1- to 4-in. for Saskatchewan Power Company, and 8 miles of 4-in. for Imperial Oils Ltd., between Devon field and Bottery.

Bechtel Corporation, 220 Bush Street, San Francisco, California, is acting as agent for the Lakehead Pipe Line Company, in completing the $76,000,000 635-mile, 30-in. pipe line between Superior, Wisconsin, and the international boundary south of Port Huron, Michigan, and Sarnia, Ontario.

Bechtel construction crews are completing the section from Mackinaw City to Red Oak, Michigan. The field office is at Gaylord, Michigan, with M. A. Roberts superintendent.

Another project by this company is 63 miles of 24-in. for the Tennessee Gas Transmission Company, from Kane to Coudersport, Pennsylvania. The field office is at Kane. J. L. Work is superintendent and K. F. Kenna office manager.

Bills Construction Company, Tulsa, Oklahoma, is working on 2½ miles of 8-in. line for Buckeye Pipe Line Company between Cartaret and Linden, New Jersey. Company also has river crossing on Rahway River. Carl W. Bills is superintendent and Kenneth Mills, welding foreman. V. Grizzell is office manager at the Plainfield, New Jersey, office.

Brown and Root, Inc., 4100 Clinton Drive, Houston, Texas, is working on 194 miles of 6, 8, 12, and 20-in. pipe line for Southern Natural Gas Company in the coastal area of Louisiana. From the Mississippi River east for a distance of approximately 144 miles, the spread is in charge of Jim Kincy, with field headquarters at New Orleans.

O. R. Burden Construction Corporation, P. O. Box 5216, Tulsa, Oklahoma, is constructing 153 miles of 12-in. and 16-in. crude oil line for Service Pipe Line Company between Tioga and Mandan, North Dakota. Two river crossings also will be installed. The field office is at Tioga. A. B. Haynes is superintendent and J. R. Perkins office manager.

Company also has approximately 51 miles of take-up for Sinclair Pipe Line Company on an 18-in. line in Missouri and Kansas.

Company has 65 miles of 10-, 12-, and 16-in. line in South Texas for Texas-Illinois Natural Gas Company.

Company has 45 miles of 18-in. line from Cushing to Shawnee, Oklahoma, for Sinclair Pipe Line Company.

Canadian Parkhill Pipe Stringing, Ltd., 21 King Street, Toronto, Ontario, has sub-contract for stringing 200 miles of 8-in. for Sun Oil Company. Williams Brothers holds prime contract.

Contracting and Material Company, 1235 Dodge Avenue, Evanston, Illinois, is constructing 20 miles of 30- and 36-in. line for Chicago District Pipe Line Company. A. J. Fry is superintendent and J. H. Myers office manager.

Conyes Construction Corporation, 2884 San Pablo Avenue, San Pablo, California, has completed nearly 80 per cent on 180 miles of 30-in. line for Lakehead Pipe Line Company from Red Oak to Marysville, Michigan. Two spreads are in operation, with J. L. Walker, Morris A. Norwood, and Chet Kinkaid, superintendents of the projects.

Dunn Brothers, 801 Mercantile Building, Dallas, Texas, has the following hauling, stringing and unloading jobs:

154 miles of 16-in. for Magnolia Pipe Line Company's Ringgold-Corsicana line. Prime contractor is H. B. Zachry.

150 miles of 30-in. for El Paso Natural Gas Company between Denver City, Texas, and Corona, New Mexico. Prime contractor is Oklahoma Pipe Line Constructors.

164 miles of 30-in. for El Paso between Flagstaff and Kingman, Arizona. Prime contractor is Western Pipe Line Constructors.

355 miles of 30-in. for Gulf Interstate Gas Company between Kinkade, Tennessee and Kenova, West Virgina. Prime contractor is H. C. Price Company.

230 miles of 30-in. for El Paso between Winslow, Arizona and Gallup, New Mexico. El Paso is handling own job.

Approximately 300 miles of 4- to 6-in. pipe for El Paso for a gathering system in the Farmington, New Mexico, area. El Paso doing own construction.

30 miles of 30-in. for schedule I-A of the Lakehead Pipe Line Company project. Prime contractor is Bechtel.

96 miles of 16-in., 8 miles of 12¾-in., and 37 miles of 8⅝-in. for East Tennessee Natural Gas Company. Prime contractor is Engineering-Construction Company.

Foster Wheeler Corporation, 165 Broadway, New York 6, New York, has contract with North Atlantic Treaty Organization for management of 1920 miles of product lines to be laid in Western Europe. The NATO pipe line network will have 4- to 10-in. lines and will cost $100,000,000.

Hoss Heavy Haulers, Laurel, Mississippi, is stringing 107 miles of 22-in. line for River Construction Corporation on an Interstate Oil Pipe Line Company project between Shreveport and Bunkie, Louisiana.

CONTRACTORS

C. W. Fowler, Cotton Valley, Louisiana, is working on 65 miles of 12-in. line and 10 miles of 8-in. line between Bobstown and Seadrift, Texas, for Seadrift Pipe Line Company. R. B. Kemper is superintendent and W. G. Barnett office manager at the Refugio, Texas, field office.

Fulghum Contracting Corporation, Box 1181, Harrisburg, Pensylvania, is finishing up 51.5 miles of 14-in. pipe line between Dupont, Pennsylvania, and the Pennsylvania-New York state line for Buckeye Pipe Line Company. A. L. McMillon is superintendent at the Montrose, Pennsylvania, field office. Dick Jablonowski is office manager.

R. H. Fulton and Company, P. O. Box 1526, Lubbock, Texas, is constructing 63 miles of 18-in. line for El Paso Natural Gas Company between Clear Creek and Provo, Utah. Superintendent in charge is Jerry Nash with Jack Frazer the office manager.

Fulton is working on 260 miles of 16, 20, 24, 26, and 30-in. line for the Permian Basin Pipe Line Company in loops from Hobbs, New Mexico, to Denver City, Texas, to Midland, Texas, to Rankin, Texas, and back to Hobbs. Two spreads are working on the job. M. L. Boyd is superintendent at the Midland, Texas, field office, and Oscar Phillips is superintendent at the Hobbs, New Mexico, field office.

Underway also are 90 miles of 30-in. loop line for Permian Basin Pipe Line Company between Perryton, Texas, and Noals, Oklahoma. Vance Albers is superintendent and Claude Helweg, office manager.

Fulton also has 50 miles of 20-in. pipe between Hugo and Eads, Colorado, for Colorado Interstate Gas Company. Jim Gill is superintendent and Frank Tidwell office manager.

Also in progress are 250 miles of 30-in. line for El Paso Natural Gas Company between Corona and Gallup, New Mexico. A. A. Carrigan is superintendent and Bill Cohoon office manager.

G. G. Griffis Construction Company, 4450 East Admiral Place, Tulsa, Oklahoma, is working on three loops in Iowa for Northern Natural Gas Company. G. G. Griffis is general superintendent, Hook Miller spreadman, and R. H. Holmes, office manager at the Cherokee, Iowa, field office. The three loops are a 27-mile, 24-in. line, a 40-mile, 30-in. line and 32-mile, 30-in. loop.

Houston Contracting Company, Ltd., 2707 Ferndale Place, Houston, Texas, has the following construction work:

Approximately 440 miles of 14-, 16-, 18-, 20-, and 24-in. natural gas lines for Southern Natural Gas Company in Georgia, Alabama, Mississippi, and Louisiana. Spreads now working as follows:

Approximately 82 miles of 16-in. and 35 miles of 14-in. from Bass Junction, Georgia, to a point south of Wrens, Georgia. H. L. Leake, superintendent; S. B. Harrison, assistant superintendent; George A. Warner, field office manager; present headquarters, Milledgeville, Georgia. Approximately 50 miles completed.

Approximately 120 miles of 14- and 16-in. in Georgia has been sub-contracted to Latex Construction Company of Georgia. Present headquarters Sylvania, Georgia. Approximately 55 miles completed.

Approximately 20 miles of 18-in. reconditioning for Texas Gas Transmission Corporation near Greenville, Mississippi. H. J. Muckley, superintendent; A. E. Stremmel, field office manager; headquarters, Greenville, Mississippi.

Approximately 500 miles of 30-in. natural gas line for Gulf Interstate Gas Company from Rayne, Louisiana, to Kinkade, Tennessee. Three spreads on this work as follows:

From Mississippi River going north, E. C. Norris, superintendent; R. E. Thornton, assistant superintendent; R. J. Axsom, field office manager; present headquarters, Greenwood, Mississippi. Approximately 20 miles completed.

From Ouachita River going south, F. A. Silar, superintendent; L. F. Redfearn, field office manager; headquarters, Jena, Louisiana.

From Ouachita River going north, M. L. Thompson, superintendent; J. B. Stoddard, field office manager; headquarters, Winnsboro, Louisiana.

A. C. Holder Construction Company, 2615 East Admiral Place, Tulsa, Oklahoma, is working on 90 miles of 6- and 12-in. crude line take-up and reconditioning for a Humble-Chicago Pipe Line project between Buckner, Missouri, and Iola, Kansas. A. C. Holder is superintendent and J. D. Langley, office manager.

Engineers Limited Pipeline Company, 225 Bush Street, San Francisco, California, is working on 25 miles of 18-in. line in Wyoming for Mountain Fuel Supply Company. Also underway is construction of 40 miles of 6-in. products line for Salt Lake Pipe Line Company between Adams, Oregon, and Pasco, Washington. Superintendent is C. P. Hamilton and Virgil Dalby is office manager.

L. E. Farley, Inc., 5247 Buffalo Speedway, Houston, Texas, has contract for approximately 40 miles of gathering lines, 6- to 12-in., for Texas Pipe Line Company in Louisiana. W. L. Barton is superintendent and Jess Finley spreadman.

Mary Construction Company, Cape Girardeau, Missouri, is working on 80 miles of 8-in. products line for the Indiana Farm Bureau Cooperative Association. The pipe is being laid between Switz City to Peru, Indiana. Garland Mims is superintendent and Lewis Wiist office manager.

R. B. Potashnick, Cape Girardeau, Missouri, is completing 101 miles of 10-in. pipe line for Standard Oil Company of Indiana. Job is between Colon and Romulus, Michigan. A. G. Hobson is superintendent and V. E. Connor office manager.

H. C. Price Co., Pipeline Division, P. O. Box 1111, Bartlesville, Oklahoma, has the general contract covering construction of approximately 355 miles of 30-in. high pressure natural gas pipe line for Gulf Interstate Gas Company starting at a point near Kinkade, Tennessee, and extending northeasterly to a point near Kenova, West Virginia.

A general contract covering construction of 200.4 miles of 24-in. loop and new lines for Southern Natural Gas in Mississippi, Alabama, and Georgia, and work is in final stages.

Spreads in operation include spread one, Stanford, Kentucky, G. A. Reutzel, superintendent; spread two, Irvine, Kentucky, R. L. Ezell, superintendent; spread three, Leeds, Alabama, C. E. Shivel, superintendent; spread four, Kosciusko, Mississippi, C. R. Ice, superintendent, and spread five, Columbia, Kentucky, W. H. Olrich, superintendent.

Holdran Construction Company, Mount Vernon, Illinois, is working on an undetermined amount of cross-country transmission lines and city distribution lines near Rock Island, Illinois, for Iowa Illionois Gas and Electric Company. H. W. Randall is superintendent and N. W. McCoy office manager.

Pipe Line Construction and Drilling Company, Indiana, Pennsylvania, is working on 50 miles of 14-in. line for Buckeye Pipe Line Company between Allentown and Wilkes-Barre, Pennsylvania. Merrel Foudray is superintendent in charge and Fred Droddy office manager at Berlinsville, Pennsylvania.

Engineering-Construction Company, 402 North Cheyenne, Tulsa 6, Oklahoma, is working on 94 miles of 16-in. line for East Tennessee Natural Gas Company between Knoxville and Kingsport, Tennessee. Also being laid on the same job are 56 miles of 4- through 12-in. line in laterals from the main line. Bob Blackmon is spreadman and Emerson H. Clark, office manager, at the Morristown, Tennessee, office.

In the vicinity of Columbia, Tennessee, the company is working on 20 miles of 6-in. line. Curt Vaughan is spreadman and V. L. Bethel, office manager.

Jobs contracted for include construction of approximately 65 miles of 4- through 26-in. line near Elkhart, Kansas, for Colorado Interstate Gas Company and work for the city of Dallas, Georgia, on transmission and distribution lines. Earl Hackleman is spreadman and H. B. Hoge office manager on the Elkhart job. No starting date has been announced on the Georgia job.

Lone Star Constructors, 10301 Shady Trail, Dallas, Texas, is constructing four loops, totaling 70 miles, of 30-in. for Northern Natural Gas Company. Three of the loops, one in Nebraska and two in Kansas, have been completed. H. A. "Red" Wylie is superintendent in charge and J. K. Little office manager at the Ellsworth, Kansas, field office.

Parkhill Truck Company, P. O. Box 1856, Tulsa, Oklahoma, reports the following work:

Ninety-one miles, Section I, unloading, stockpiling, and stringing of the 630-mile, 30-in. pipe line from Superior, Wisconsin, to the International Boundary, for Mahoney Contracting Company, contractor for Mackinac Pipe Line Company, Inc.

Ninety-seven miles, unloading, storing, and stringing on the same system for Midwestern Constructors. Also hauling and storing of about 9 miles of 20-in. river pipe from St. Ignace, Michigan, to the Mackinac Straits for Midwestern Constructors, Inc.

Stringing 280 miles of 14-in. and 320 miles of 8-in. takeup for Shell Oil Company from Wood River, Illinois, to East Chicago, Indiana. The prime contractor is R. B. Potashnick Company.

Stringing 180 miles of 8-in. pipe for the Indiana Farm Bureau between Mount Vernon, Illinois, and Indianapolis, Indiana. The prime contractor is R. B. Potashnick.

Stringing 16-in. line pipe on the Wolverine line from East Chicago, Indiana, to a point near Marshall, Michigan, for Midwestern Constructors, Inc.

Stringing from El Dorado, Kansas, to Arkansas City, Kansas, 74 miles of 8⅝-in. pipe, and 130 miles of 10¾-in pipe from Potwin to McPherson, Kansas, and Fairmount, Nebraska, for Ray L. Smith and Son, Inc.

Hauling 30-in. pipe for Gulf Interstate Gas Company from Houston and Orange, Texas, to storage points in eastern Louisiana and Mississippi.

Stringing 40 miles of 6-in. pipe from a point near Pasco, Washington, to a point near Adams, Oregon, for Engineers Limited Pipeline Company on Salt Lake Pipe Line Company job.

H. B. Zachry Company, Box 2570, San Antonio 6, Texas, is working on 154 miles of 16-in. pipe between Ringgold and Corsicana, Texas, for Magnolia Pipe Iine Company. Two spreads are in operation. D. B. Shrum is superintendent and Ray Shields office manager of spread one at Ennis, Texas. W. L. Huff is superintendent and D. Trice office manager at spread two in Decatur, Texas.

Western Pipe Line Constructors, Box 798, Austin, Texas, is working on 164 miles of 30-in. line for El Paso Natural Gas Company between Kingman and Flagstaff, Arizona. Benny Williams is superintendent and P. O. Rutledge office manager at the Williams, Arizona, field office.

Williams-Austin Company, Grant Building, Pittsburgh, Pennsylvania, has started work on aproximately 11 miles of 20-in. line in the Caledonia, New York, area for New York State Natural Gas Corporation. Ralph Gaddy is in charge.

Work is underway on 11.5 miles of 12-in. pipe for Niagara Mohawk Power Corporation between Amsterdam and Gloversville, New York, with Howard Bauer supervising. Ed Peters is general superintendent and L. A. Franks office manager. Central warehouse is at Cortland, New York.

Company has 10 miles of 12- and 16-in. line at Driftwood, Pennsylvania, for Manufacturers Light and Heat Company. H. C. Bauer is superintendent. Company has 12 miles of 12-in. in Washington County, Pennsylvania for same firm. O. L. Martin is superintendent.

Eastern Pipe Line Contractors, 1801 Mercantile Bank Building, Dallas, Texas, has contract for two sections of the Yellowstone Pipe Line System between Billings, Montana, and Spokane, Washington. Eastern will build 158 miles of the 10-in. line, with one year's time allotted for the job. Right-of-way work and rock ditching are underway. Two spreads will be used, one working west from Clinton, Montana, and another east out of Murray, Idaho. A. L. "Bull" Stewart is superintendent and J. W. Arthur, office manager. Other personnel will be named later.

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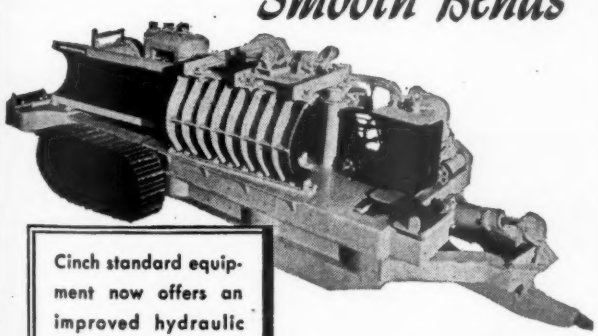

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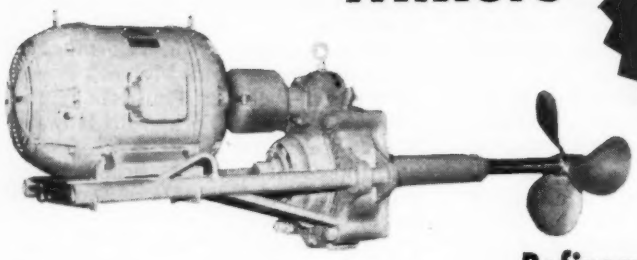

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CONTRACTORS

Mahoney Contracting Company, 2300 North Grand River, Lansing, Michigan, is progressing on 91 miles of 30-in. pipe for Lakehead Pipe Line Company between Superior, and Hurley, Wisconsin. Field office is in Ashland, Wisconsin. Henry Mogg is general superintendent; Mike Finnerty, superintendent; Al McConnell, office manager; H. F. Emerson charge of front end; Ray Abney, charge of back end; Frank Barnard, material manager; John Kohler, ditch; Bill Morry, bending; Glen Goodson, pipe; George Hastings, welders; H. L. Sparks, dope, and Joe Gilbert, cleanup.

Williams Brothers Company, National Bank of Tulsa Building, Tulsa, Oklahoma, is working on a gathering system in the Williston, North Dakota, area for Signal Oil and Gas Company, which will connect with the latter's gasoline plant. Approximately 150 miles of pipe, 4 in. through 30 in. will be laid. Eddie Hubach is in charge of work at the Tioga, North Dakota, field office.

Between Sarnia and Toronto, Ontario, Canada, work is underway on approximately 200 miles of 8-in. line for Sun Oil Company. Jimmy Childress is superintendent, Field office is at Strathroy, Ontario, Canada.

Company has contract for 165 miles of 12- and 18-in. gas line between Aiken, Charleston and Summerville, South Carolina, for South Carolina Gas Corporation.

Shamrock Construction Company, 307 Mutual Building, Lansing, Michigan, has started on 22 miles of 18-in. line for Ohio Fuel Gas Company between Centerville and Selma, Ohio. Frank Park is superintendent and Hank Van Drie office manager. Same crew has 10½ miles of 8-in. line for Sohio Company near Cincinnati, Ohio.

Ray L. Smith and Son, Inc., Hazlett Building, P. O. Box 391, El Dorado, Kansas, is constructing 280 miles of 8- and 10-in. products line between Arkansas City, Kansas, and Fairmont, Nebraska, for Kaneb Pipeline Company and Augusta Pipe Line Company. Three spreads are in operation. R. M. Jones is superintendent and Tom Davis office manager for spread one; Carl S. Colvin is superintendent and Don Steffes office manager of spread two, and Dewey Whitworth is superintendent and D. L. Marley office manager on spread three.

El Paso Natural Gas Company, El Paso, Texas, has crews working on 300 miles of 4- to 16-in. gathering system lines near Bloomfield, New Mexico, at the Blanco field. Superintendent is Joe Self and B. R. Jones, office manager.

El Paso crews are also starting on 200 miles of 30-in. line from Winslow, Arizona, to Gallup, New Mexico. J. E. Lowry is job superintendent and J. S. Smith, office manager.

CONTRACTORS

Midwestern Constructors, Inc., 105 North Boulder, Tulsa 3, Oklahoma, is completing 97 miles of 30-in. pipe line between Cooks and St. Ignace, Michigan, for Lakehead Pipe Line Company. M. T. Wilhite is superintendent. John Work, spreadman, and A. T. Tolbert, office manager, at St. Ignace.

Construction has been completed on the 2750 ft of 30-in. underwater crossing of the St. Clair River at International boundary between Sarnia and South Port Huron for Lakehead Pipe Line Company.

Work is nearly complete on a subcontract for land work from Merritt-Chapman and Scott Corporation for two 22,000-ft 20-in. lines across Mackinac Straits, between Port LaBarbe and McGulpin Point, Michigan, for Lakehead.

Work is complete for Texas Illinois Pipe Line Company on station additions at Hoffman, Illinois, and construction is progressing on a compressor station at Hammond, Illinois. J. M. Graham is superintendent at the Hoffman site; Ray M. Johnson is superintendent; W. C. Ryan, office manager, and Lonnie Dorman and John Hoff, engineer at the Hammond job.

Work on 153 miles of 16-in. line east side of Kalamazoo River in Michigan to Kennedy pump station at East Chicago, Indiana, is progressing. M. T. Wilhite is superintendent, John Petty, spreadman, and A. T. Tolbert, office manager. Office is at Battle Creek, Michigan.

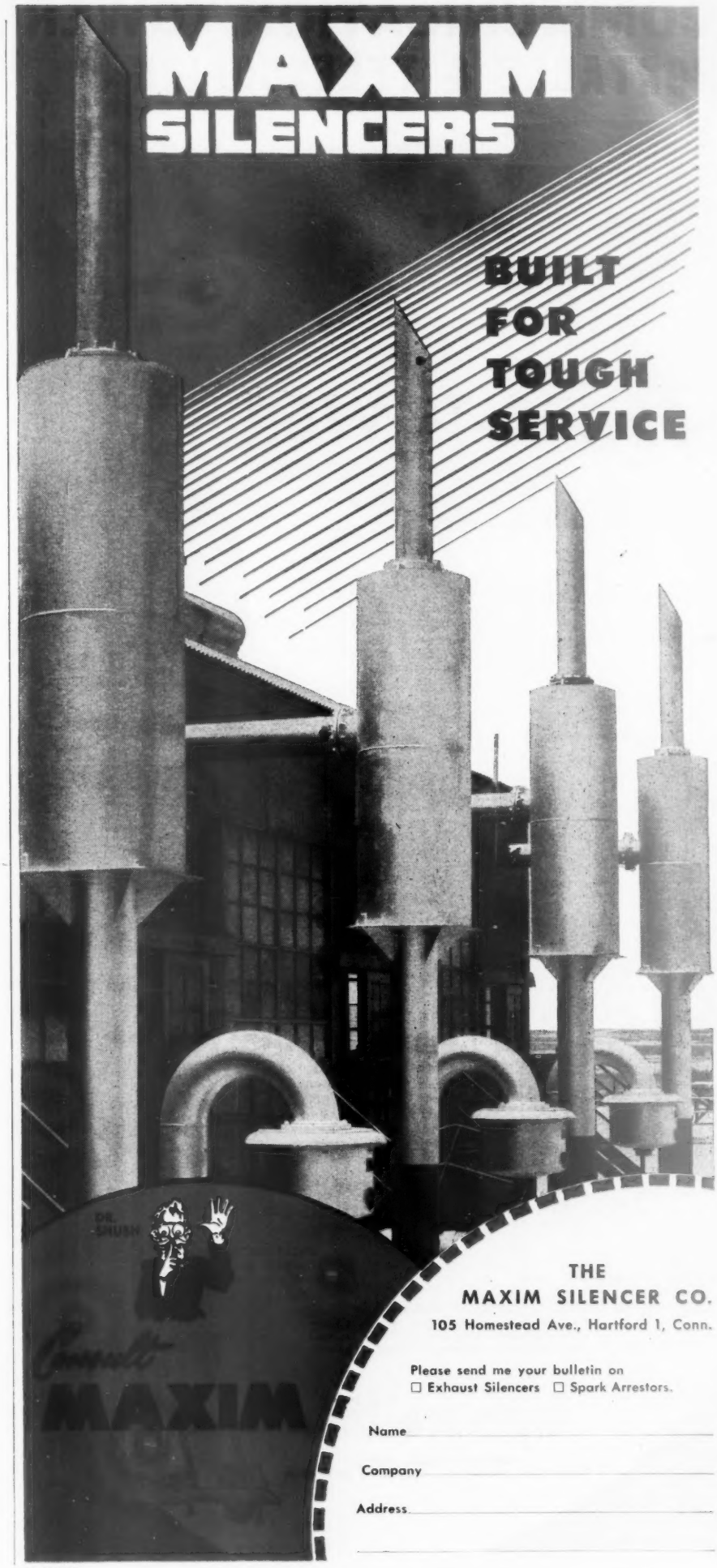
Somerville Construction Company, Ada, Michigan, has 35 miles of 6- to 24-in. line for Michigan Consolidated Gas Company near Six Lakes, Michigan.

Tellepsen Construction Company, Houston, Texas, is constructing an underwater gas gathering system in Lake Maracaibo, Venezuela, for Creole Petroleum Company. The system will embrace about 14 miles of 24-, 26-, and 30-in. pipe.

Latex Construction Company of Georgia, P. O. Box 56, North Side Station, Atlanta, Georgia, is working on 294 miles of 14, 16, and 18-in. pipe line for Southern Natural Gas Company in Alabama and Georgia. Field headquarters are in Augusta, Georgia, with J. M. Phipps superintendent, Jim Davenport, spreadman, and A. C. Andrews office manager.

Lyles and Young Company, P. O. Box 495, Avenal, California, is working on 136 miles of 8-in. line for Salt Lake Pipe Line Company, from Pasco to Spokane, Washington. Ronny Cook is superintendent, C. V. Miller, project manager, and C. E. Smith office manager.

McDonough Construction Company of Georgia, Atlanta, Georgia, is working on 50 miles of 6- and 8-in. line for the Cullman-Jefferson Counties Gas District. D. B. Samford is superintendent and J. A. Preston, office manager.



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The EREC-TOWER consists of three 24-foot heavy-duty aluminum tower sections that telescope up to 80 feet with the receiving and sending antenna. It is mounted on a heavy-duty trailer that will road at plus 60 m.p.h. Transmitter and receiver can be mounted right on the trailer, crank the collapsed tower into upright position, telescope the tower to 80 feet, press the mike button and start talking.

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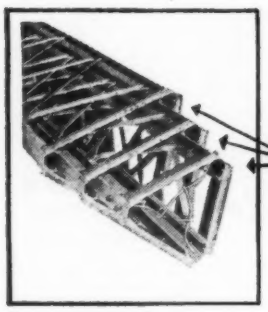

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CONTRACTORS

River Construction Corporation, 6100 Bowie Boulevard, Fort Worth, Texas, is taking up 1600 miles of 8- and 12-in. line for Sinclair Pipe Line Company in Kansas, Missouri, Illinois, and Indiana.

Work on 107 miles of 22-in. line from Bunkie to Shreveport, Louisiana, has started. Jim Reed is superintendent and Pat Rogan office manager. On one spread, field office is at Melville, Louisiana. T. M. Tatom is superintendent and Lee Price office manager at the other spread, office is at Natchitoches, Louisiana.

Company has contract for 73 miles of 30-in. line in Riverside County, California, for Southern California Gas Company.

Oklahoma Pipe Line Constructors, 6612 Harry Hines Boulevard, Dallas, Texas, is laying approximately 150 miles of 30-in. for El Paso Natural Gas Company between Denver City, Texas, to a point near Roswell, New Mexico. Two spreads are working on the job. Louis Visentine is superintendent of spread one. E. R. Law is superintendent of spread two and Gene Gohring is assistant superintendent. R. F. Mueller is office manager and Geno Gallina purchasing agent at the Lovington field office.

Lone Star Gas Company, Dallas, is working on a 44-mile, 12-in. line in Northeast Texas between Red Springs field and Sulphur Springs in Hopkins County. Directing construction is Luther Tolbert, Lone Star pipe line superintendent. Earl Miller is construction foreman.

Collins Construction Company, Victoria, Texas, has contract from Merritt-Chapman and Scott of India for construction of 84,000 ft of submarine line in the harbor at Bombay, India.

Pentzien, Inc., Omaha, Nebraska, is constructing a Missouri River crossing near Bismarck, North Dakota, for Standard Oil Company of Indiana's new line. James Zeman is superintendent and the field office is at Bismark.

Company has completed Missouri and Little Missouri River crossings in North Dakota for Service Pipe Line Company. Forrest Andrews is superintendent.

The Kuljian Corporation, 1200 North Broad Street, Philadelphia 21, Pennsylvania, has 11 miles of 4-, 16-, 20-, and 30-in. line at the Esso Standard, Intra-Refinery Oil Company refinery at Bayway, New Jersey. Engineers in charge are R. F. Rundell, Charles Avon, Hiram Jones, and John F. Pearce.

Panama-Williams Company, 1417 Melrose Building, Houston, Texas, has contract for approximately 65.6 miles of 4½- through 12¾-in. line for The Texas Pipe Line Company in south Louisiana, including six gathering pump stations to be mounted on piling over water and one station on land.

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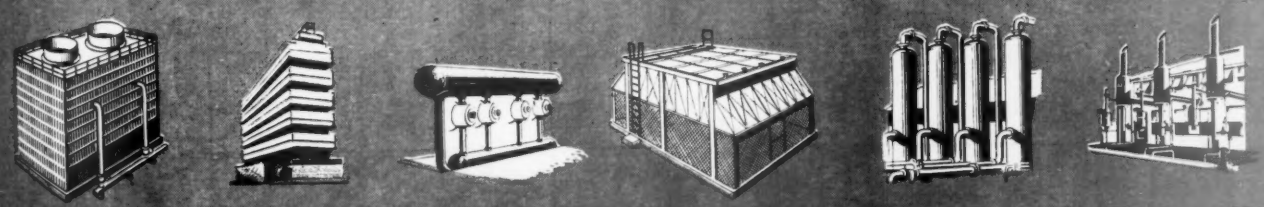

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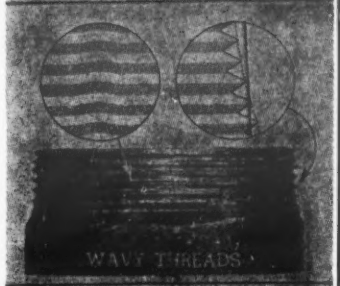
CHART FOR CORRECTION OF PIPE THREAD TROUBLES*

When threads look like these	Hand Threading		Machine Threading	
	Inspect for...	Correction	Inspect for...	Correction
	Dull chasers (Check by inspection.)	Sharpen	Dull chasers	Sharpen
	Insufficient lubrication (This not only makes poor threads but damages chasers.)	Use plenty of good oil (Sulphur base threading oil plus little lard oil gives good results.)	Insufficient lubrication	Flood with good oil (Sulphur base plus little lard oil gives good results.)
	Improper lead shape (Usually due to improper grinding.)	Grind properly	Improper lead shape	Grind properly
	Excessive or insufficient lead cutting angle	Grind to correct angle	Improper lead cutting angle	Regrind to proper angle
	Broken tooth in chaser	Grind out entire tooth	Broken tooth in chaser	Grind out entire tooth
	Chasers not set to form true cutting circle	Clean slots—set chasers to true cutting circle—grind chasers to make them of uniform length	Chasers not set to form true cutting circle	Correct setting
	Improper lead of chaser	Regrind lead	Improper lead of chaser	Regrind lead
	Chasers not tracking properly	Keep slots clean	Chasers not tracking properly	Keep slots clean
	Chasers not set in due rotation	Correct setting	Chasers not set in due rotation	Correct setting
			Carriage travel retarded	Repair carriage
	Die or chasers not set true	Center die or chasers	Loose chasers (Play in slot lets chasers tilt, increasing clearance.)	New die head
	Thumb screws not tight	Tighten screws with wrench		
	Worn-out lead screws	Get new die stock		
	Cuttings or dirt in chaser slots	Keep slots always clean	Worn cam in die head (Check lost motion due to worn cam.)	New die head
	Pipe ends not square (Die starts on same angle as end cut, and threads diagonally. This trouble often wrongly blamed on "out-of-round" pipe.)	Cut pipe end square to axis of pipe and rethread	Misalignment of die and chuck	Check and re-align

*This table may be filed under P 432.4 or 622.21

Do's and Don'ts in Threading

Don't try to work with dull tools. No craftsman can do good work with poor equipment.

Don't put new or sharpened chasers in a worn stock, and expect to get first-class results. After the stock is worn out, it should be discarded.

Don't skimp on oil—either in quantity or quality. Good oil pays dividends in better work, and longer die life.

Don't try to use a set of chasers after long use or abuse has impaired its precision. Discarding worn out chasers is sound economy.

Don't forget to center accurately the die and tighten the thumb screws WITH A WRENCH in hand threading, and don't forget to line up the pipe properly in the grips in machine threading.

Be sure to clear slots of all dirt, gummy oil, chips, etc., when you change chasers. Keeping tools clean lengthens their life.

Be sure, when the chasers are reground, that it is done by someone who knows how, or who will accurately follow directions. Wrong grinding can ruin chasers, spoiling a multitude of threads.

Be sure that the pipe ends are cut off square and true. Give the die a fair chance, so it can start on straight.

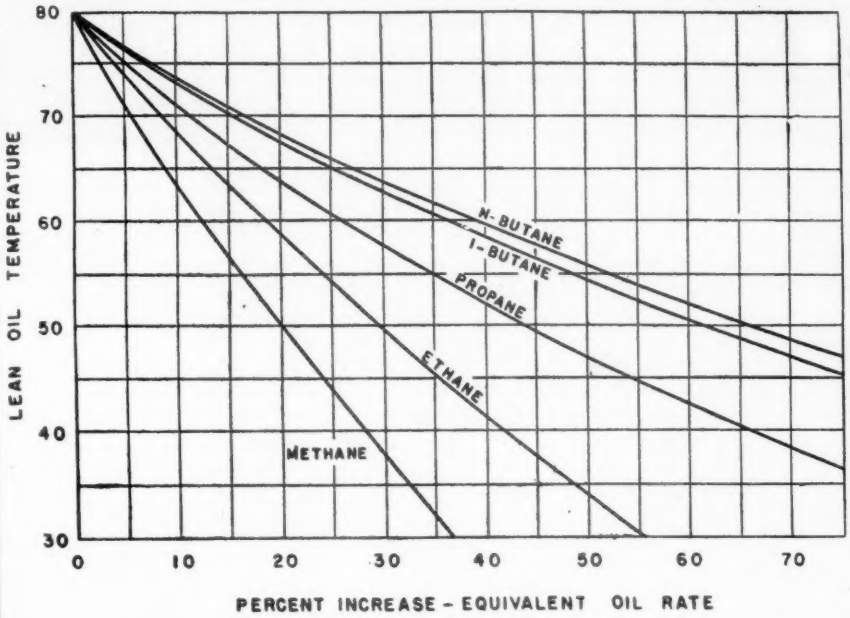
When trouble occurs, check up your equipment carefully. It may be that the trouble is something that a little adjustment will fix. In any case, the difficulty can be corrected with a minimum of cost and lost time.

And finally, cut the thread long enough to engage fully the threads in the fitting. A thread like the one illustrated below, is too short to resist mechanical forces caused by expansion and contraction, vibration, and so forth.

Material supplied by A. M. Byers Company, Pittsburgh, Pennsylvania

REFRIGERATION DATA FOR GASOLINE PLANTS

FIG. 1. OIL TEMPERATURES VS. EQUIVALENT OIL RATE.



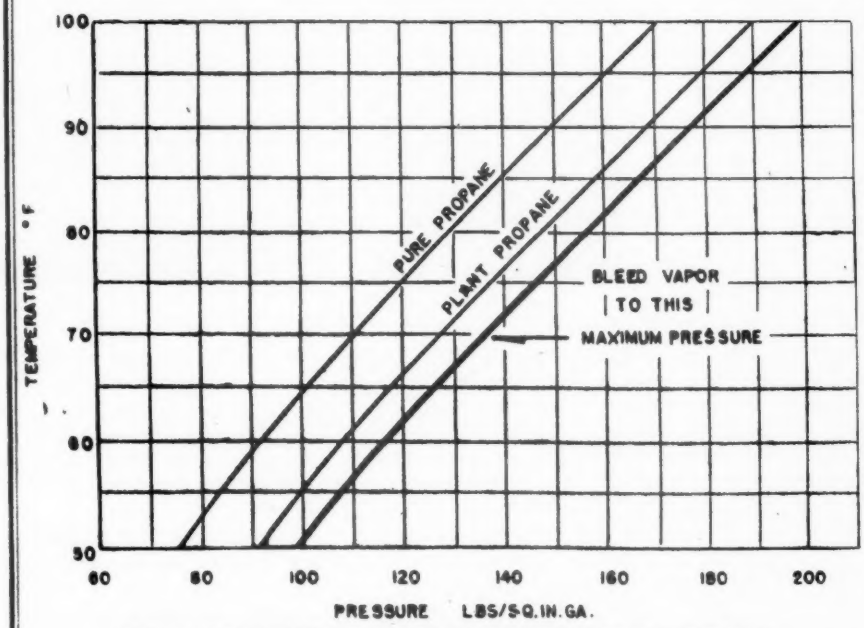


FIG. 2. CONDENSER, PRESSURE-TEMPERATURE CURVES.

These curves and table are taken from the article entitled "Practical Refrigeration for Natural Gasoline Plants," by R. W. Heath, J. B. Taylor, Jr., and P. W. Hill of the Signal Oil and Gas Company that was published in the May 1946 issue of *The Petroleum Engineer*, pages 162 to 176.

Fig. 1 (left) shows the relationship between lean oil temperatures below 80°F. and the increase in absorption of the oil as the temperature is reduced by refrigeration.

For example:

Lowering the temperature from 80°F. to 55°F. is equivalent to increasing the oil rate 50 per cent insofar as the butanes are concerned, 35 per cent for propane, 24 per cent for ethane, and 17 per cent for methane.

Fig. 2.—This is a curve based on the actual analysis data in Table 1 and shows that the refrigeration capacity is best when small quantities of vapor are removed by bleeding to a limited discharge pressure.

TABLE 1—Propane analysis.

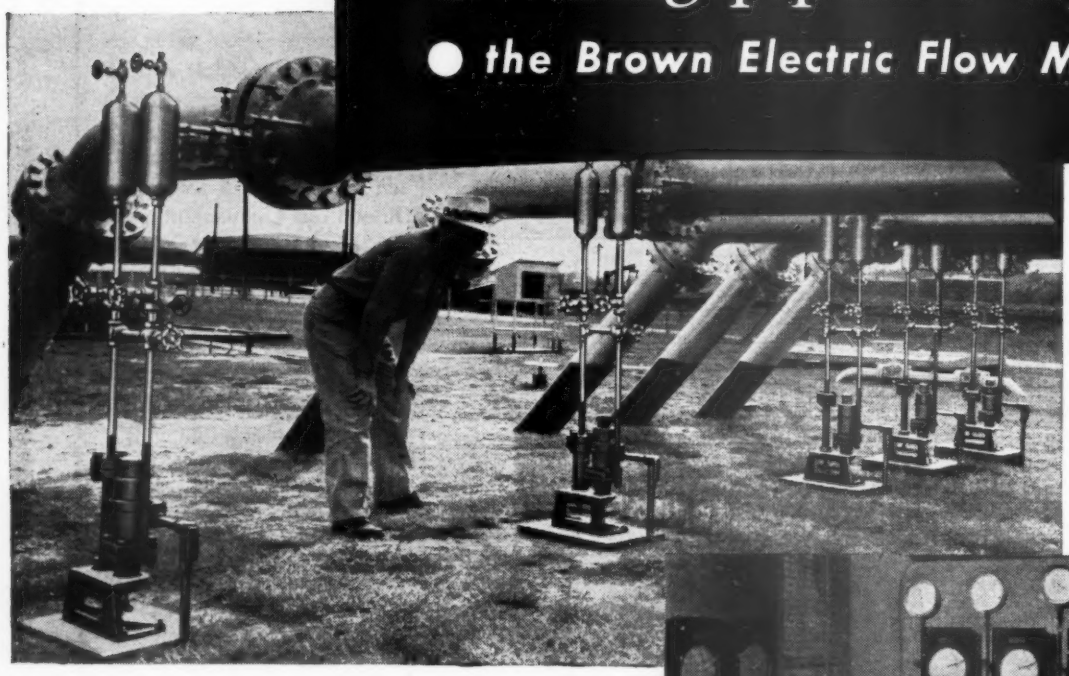
	A	B	K	D	E	F
Analysis, mol per cent						
Carbon dioxide	2.10	0.30	7.00	0.00	0.15	0.10
Methane	7.35	0.51	14.41	0.00	0.19	Trace
Ethane	7.69	2.88	2.67	0.04	2.33	1.23
Propane	82.70	95.95	0.86	98.54	96.95	98.30
Isobutane	0.16	0.36	0.44	1.03	0.38	0.27
Normal butane	0.00	0.00		0.39	0.00	Trace
Total	100.00	100.00		100.00	100.00	100.00
Specific gravity	1.421	1.531		1.551		

Explanation of Table 1:

A—Condenser accumulator vapor, 172 lb. per sq. in. abs. and 79 °F.
B—Condenser accumulator liquid. 172 lb. per sq. in. abs. and 79 °F.
Plant propane before any bleeding—vapors to compressor.
K—Equilibrium constants, A/B.
D—Liquid in chiller—lube oil removed.
E—Condenser accumulator liquid. 162 lb. per sq. in. abs. and 79 °F.
Plant propane after bleeding approximately 10 per cent off B.
F—Plant propane from Signa. Hill plant.
Specific gravity taken by Edwards Balance
A to D samples procured at Huntington Beach before bleeding and E after bleeding.

Every feature you need for metering pipeline liquids

● the Brown Electric Flow Meter



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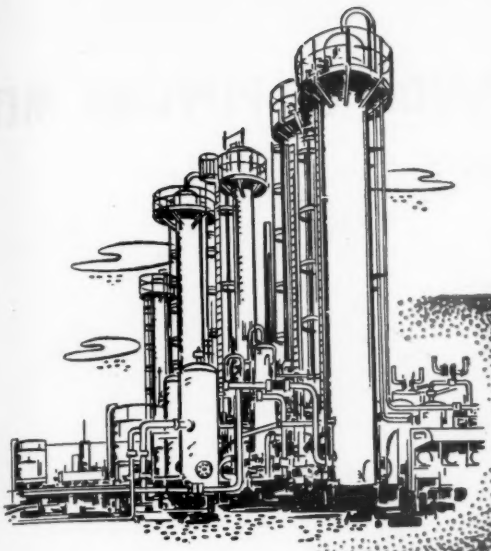

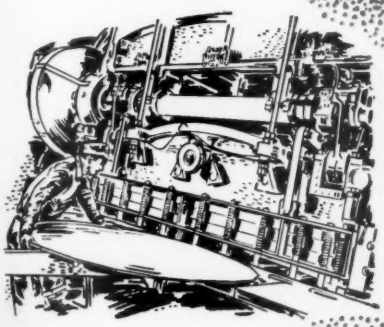

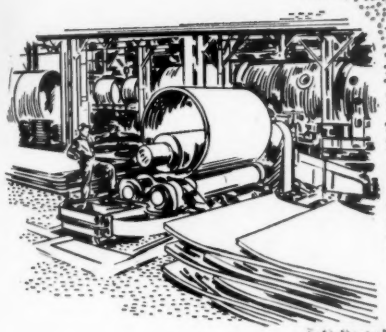

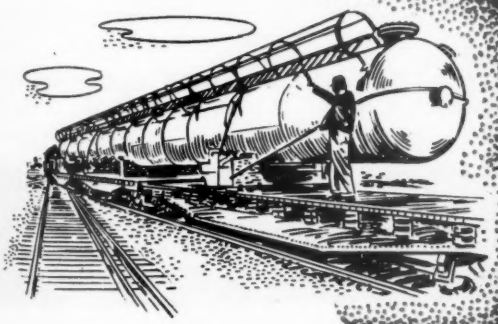

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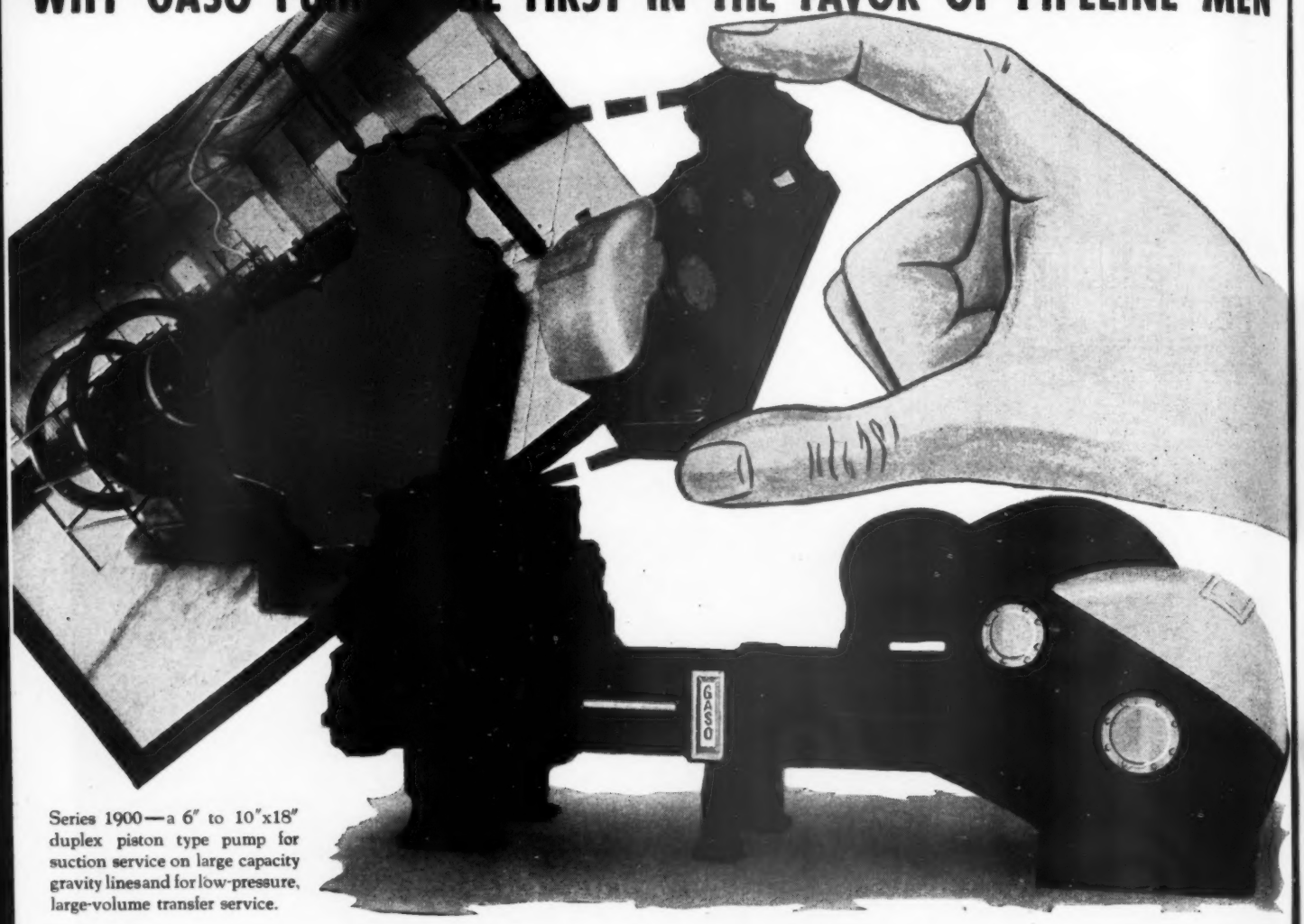

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To obtain more information on products advertised see page E-63

25-TON LIFT... 35 m.p.h. mobility

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In addition, the mobile, truck-mounted 304 does more jobs a day around refineries, plant yards, drill sites. It runs from one job to the next at 30 to 35 m.p.h., cuts non-productive moving time, turns in more work-time. Figure what these three big gains — in extra speed, extra capacity, and extra reach — can mean on your work.

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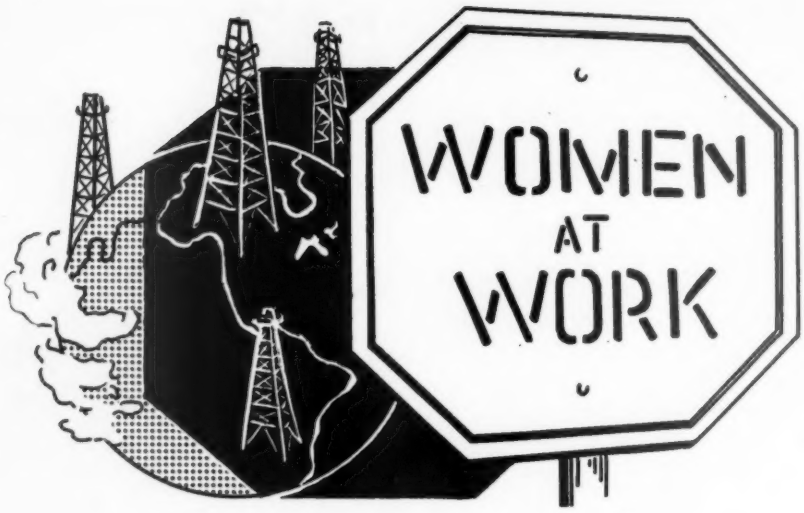


Mrs. Collins handles oil and gas leases, royalties, etc.

Begins as Office Roustabout

Anna Lee Thomason came into the oil business by the back door. Reared in Navarro County, Texas, she took her first job as a teller in a small bank and here gained experience in figures and in personalities, a double talent that has been valuable to her through the years. She left the bank to become cashier of a West Texas utility company.

Eleven years ago Anna Lee Thomason resigned her position with the utility company to enter what she enthusiastically acclaims "The Greatest Business in the World — OIL!"

"I was just a roustabout, in those days," she recalls, "and there was certainly a lot to learn."

Miss Thomason learned quickly and well. She is now assistant secretary and treasurer of Onyx Refining Company, Abilene, Texas, a position she plans to hold "until death do us part."

In addition to her exacting duties with Onyx, she is chairman of the board of the Business and Professional Women's Club, and a charter member and board member of the Abilene Desk and Derrick Club.

Traffic Circle Handler

One asset Shell Oil received when it bought Marathon Oil Company in 1936 was an attractive little brunette named **Loretta Morin.** She had been with Marathon since her graduation from Central High School, Sioux City, Iowa, where she was born and reared. When the company was sold to Shell, Miss Morin went along "as a part of the purchase."

With Marathon she advanced from stenographer in the credit department to secretary to the manager. With Shell she began as secretary to the division manager in Des Moines, Iowa, went with the company to Minneapolis, Minnesota when the division offices were moved to that city in 1938. In addition to her secretarial duties, Loretta Morin is in charge of railroad and plane reservations for all Minneapolis division Shell employees and as such she is well known in the Minneapolis "traffic circle."

On her three weeks vacation each year Loretta gets in some traveling of her own — by automobile. These trips are one of the highlights of her life. She spearheaded the organization of the Twin Cities Desk and Derrick Club in 1952 and became its first president. When she is not busily engaged in one of these activities, Loretta Morin may be found adding to her apartment ("I have an aptitude for domesticity"), yelling for her favorite baseball nine, or browsing through a gift shop, or as a first nighter at the theater, all of which have contributed to the well-rounded personality of this dynamic lady who says, "Oil runs in my veins."

Texas Oil Merchant

Mrs. Hallie Collins became an oil woman in Bowie, Texas, before Bowie became an oil town. Arriving in the small Northwest Texas town in 1939, she assembled approximately 5000 acres in a block centering around the Lee Tucker land. A short time later the first producing oil well in southwestern Montague County was brought in on the lease.

Mrs. Collins is the only woman "oil man" in the area. She handles oil and gas leases, royalties and drilling blocks. Her modern, up-to-the-minute office is maintained in her home where U. S. highways 81 and 287 merge. This combination home-office, within derrick-length of producing wells, is the center of her existence, but her busy life expresses itself in many different facets.

A widow, Mrs. Collins is active in both social and business affairs in Bowie. She is a member of the Bowie Art League, the Business and Professional Women's Club and an active church member. When church or club presents a program, Mrs. Collins is sure to be called upon for either a pantomime skit or a solo, both of which she is adept at performing.

Mrs. Collins is an enthusiastic sports spectator, but she says active participation is not for her.

Anna Lee is assistant secretary and treasurer of Onyx.

Loretta takes care of reservations for Shell group.

XUM

ARE YOU A SUPERVISOR?†

Supervisors have most comprehensive, complex, and difficult assignment, and must get loyalty by their own words and acts

R. B. SALE*

A FEW months ago, Professor A. V. Hill, president of the British Association for the Advancement of Science, opened the 114th annual meeting of that association with the following statement:

"Modern research has opened the way for unprecedented good or unlimited harm for mankind and has posed a moral issue that must be resolved before benefits can be realized."

He scored a widely held notion that natural scientists should stick to their laboratories and leave moral problems to philosophers and politicians.

Our object here is not to take issue with philosophers and politicians nor to underwrite the cybernetic revolution; but it is possibly to awaken ourselves further to the parts that we individually might play and thereby cause the work of our industry to become more effective.

Professor Hill further said that the use to which the natural sciences are put should depend upon the moral judgments of the entire community and should help guide their use, and that this should be the honorable and compelling duty of every citizen, including the natural scientists. He further said that it is easy for the research expert to dodge this issue.

We are interested in his words because they apparently were arranged after a great amount of thinking and after he had experienced much association with men in science and in industry.

Aristotle once remarked that man is by nature a social animal. This is proved to us on every side. It is because of an effort to develop our powers as social beings that we have American educational institutions.

Were some of you amazed at the methods of training exhibited toward you by your first oil-field supervisor? Only through their own improvisation have they learned to do a more effective job of supervising, because no management, except in recent years, did anything to help this most important man to cause his job to be easier or more effective.

This may sound as though we are about to declare war on people who work in the oil field in charge of other people's activities. This is not true, but your American Petroleum Institute, through its recent establishment of the National Committee on Supervisory Development, signified its intention to declare strenuous opposition to those principles that would ignore the moral and social problems that affect so deeply the relationships of men in industry.

By establishment of this program management of the API has demonstrated its intention not to become so busy with and excited about the accomplishments of people in material sciences that it will fail to give attention to a situation that now, if it continues to be ignored may kill all of the effectiveness of the discoveries which have been made in the laboratories of the material scientists.

In recent years, we have made fabulous progress in conquering nature. Our control of environment has raised us above our former dependence upon materiality, but we are not still in bondage to something else? Could it be that we are not awake to the power hidden beneath our thinking about social relationships on as well as off the job? Could it be that it is buried beneath a thickness of egotism, self-will, or false pride? What is that certain unexplainable something that happens to a man almost instantaneously when he is elevated from the position of a workman to that of a supervisor? What is it which, at that time, changes his perception of people who have to continue to do work with their hands? Do the many industrial conflicts of our day result from the fact that we have not learned how to conquer or even become aware of ourselves?

This true story may be of interest at this point. It happened a very few years ago. We received an employment application in the mail supported by a recommendation letter written by a representative of one of our formidable competitors. The recommendation was convincing, I thought. It stated that the applicant had worked for that firm several years and that his leaving caused the employment of two other men and the purchase of a two-ton truck. I promptly passed the application to one of our division superintendents, E. C. Wilbur, whom some of you know. After reading it, he handed it back to me and made me feel dejected by saying that he was not interested in such a man. I picked myself up and exclaimed "Why not?" His reply was "It doesn't say a thing about whether he can walk on water."

It is said that we have a great country and a very wonderful way of life; and those who visit outside of the reaches of our government's influence verify that that is true. It is further said that it is true only because of our capacity to produce things which men want throughout the world.

If this is true, then it is important that we analyze our ability to produce. Does it result from these three fundamental principles of industrial organization:

1. Two or more men with a common objective.
2. These two or more people have a willingness to work together in the accomplishment of that common objective.
3. These two or more people having a communication system whereby they might more quickly and effectively discuss the bringing into reality of the common objective.

Perhaps we here would do well to concentrate on principles 2 and 3, viz., the willingness of people to work together and the communication system. This involves what we commonly refer to as industrial training in human relations and some other subjects. These are the things that have heretofore been ignored to a very large extent, and the lack of which has been the foundation of the conflicts that have reduced our output of needed goods.

The goals of supervisory training might be described also in three ways, as follows:

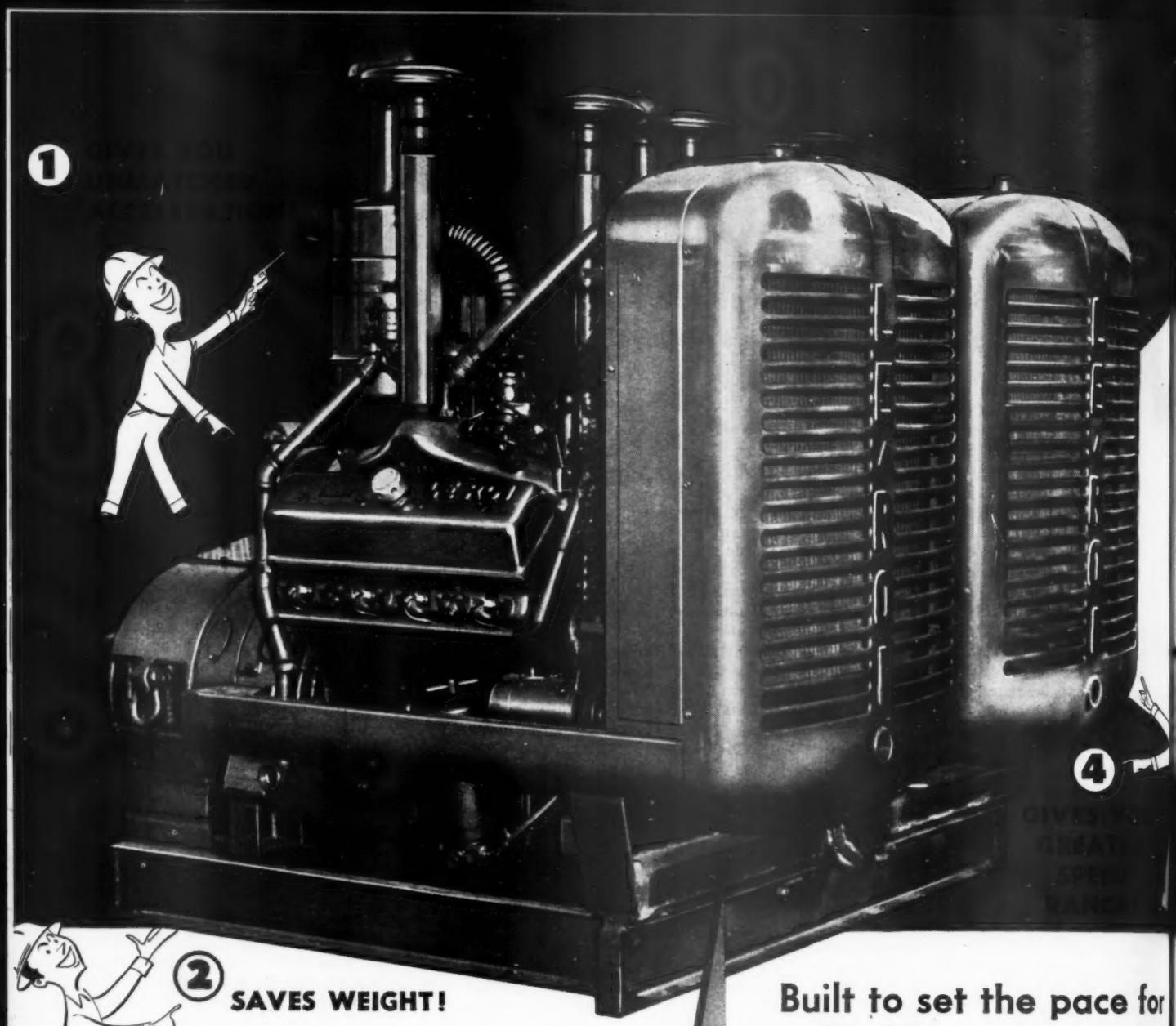
1. Training for effective diagnosis of troubles.
2. Training for effective action after discovering troubles.
3. Training for self-awareness.

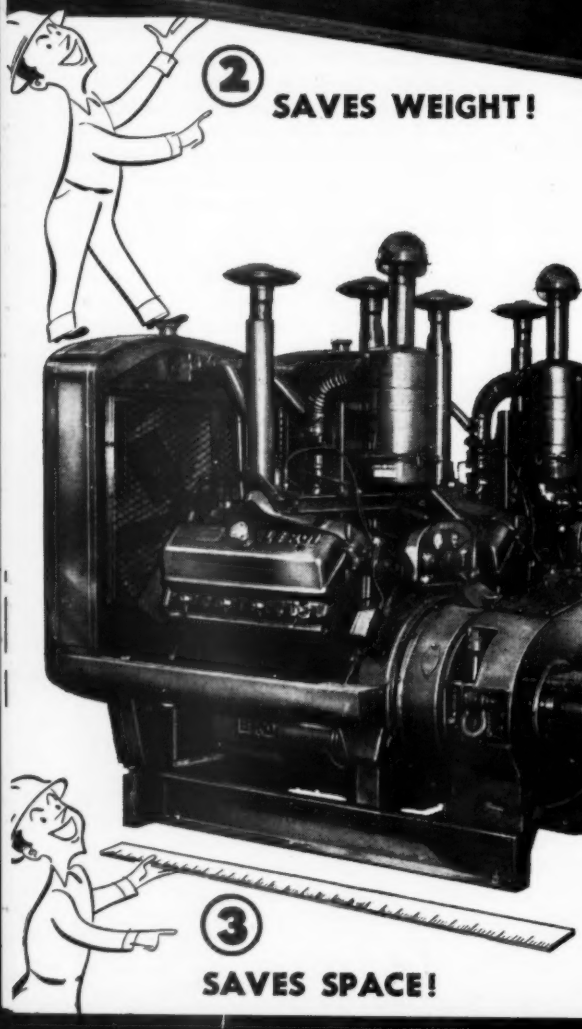
The purpose of these goals, of course, is to help the people on every level to improve continually their performance in the job situation.

With this purpose and these goals in mind to the extent that a sculptor keeps his perfect model in thought and in

†Presented at the spring meeting of the Mid-Continent district, Division of Production, Mayo Hotel, Tulsa, Oklahoma, March 18-19-20, 1953.

*Director of executive development, Continental Oil Company, Houston, Texas.





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Built to set the pace for *profitable performance!*

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2. **It gives you greater speed range!** 700 rpm to 2000 rpm.
3. **It gives you outstanding acceleration!** You get lightning-fast response to load demand.
4. **It weighs only 6700 lbs.!** You stay within weight limitations.
5. **Ratios available at power take-off:** 1-1, 1½-1, 2-1.

You can buy this new H540 Twin with full confidence of getting all the dependability, economy, and stamina that oil men have come to expect of any Le Roi. Ask your Le Roi distributor or supply house to show you the H540 Twin — the last word in oilfield power.

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sight, should we not go about our work with the high thought of molding and fashioning ourselves so as to cause the greatest amount of good to come about in our work and in our relationship with each other? In doing so, we might do well to be conscious of the frequent need for changes of our attitude and plans when expanded experience indicates the inadequacy of our beliefs.

In thinking about this thing of causing the greatest amount of good to come about in our work and in our relationship with each other, we are reminded of an editorial of the American Economic Foundation a few months ago about a famous liberal French politician and writer, Alexis de Tocqueville, who about 100 years ago visited America and wrote a book about the people he learned to know here. He stated that he sought for the greatness and genius of America in her harbors and rivers, and it was not there. He looked for it in her fields and prairies, and it was not there; in her mines and industry and commerce, and it was not there. He stated that it was not until he went to the churches of America and heard her pulpits aflame with righteousness that he understood the secret of America's genuis and power. He then said:

"America is great because she is good; and if America ever ceases to be good, America will cease to be great."

We might just as well admit it and say it here. Our very way of life depends upon allegiance to a Christian way of thinking. We are happy when our youngsters, who have gone away from home, show some evidence of becoming really interested in the principles of Christianity. Our Declaration of Independence and Bill of Rights give first acknowledgment to a power which Christians think is infinite and good. Why then is it not good for us to examine ourselves and carefully prepare our communications with each other in our work life? We are not necessarily trying to make nice people out of our men; but does it not stand to reason that, if they are going to get people to work with them more effectively, someone is going to have to think they are all right?

The common objective—the willingness to work together and the desire to communicate with each other—being the prerequisites of organization, perhaps we should give urgent thinking to the qualities of each in our own experience. If the qualities are found poor, then no doubt the organization resulting will be the same. Does it not behoove us to have them all in the highest quality possible?

There is something else about them which should be stated. These prerequisites of organization can come about quickly and vanish suddenly. For example, what becomes of organization when one line supervisor says to another: "Well, that's the last time I am going to tell that so-and-so anything." Or what happens to the organization's effectiveness when one line supervisor says of another: "If he wants to do the telling, let's just let him do the work too." Should we become so aware of ourselves in our daily contacts with each other that we shall not only be careful what we say to each other but how we say it so that all who are involved may be left with a greater sense of dignity about their job and about their importance in our organization?

Some of you work for a fine organization in our business who, a few years ago, did a very important research project in connection with this activity. You found that many of your workers and even members of your management had resigned positions in order that they might take better jobs some place else. Further work revealed that you also found that the better jobs which these people took some place else paid less money. That brought up the question of what made them better jobs. The answer you found was that they received personal values, which, when added to the amount of money, made a total sum greater than the money and personal values that they were receiving before the change.

How many of you who have worked under at least two supervisors cannot say that there is one of them for whom you would rather have worked at the same salary? In my 30 years of industrial life, I have worked under very few supervisors; but I can surely tell you that one of them stands out above all of the others, and I would rather have worked for him even at less money than for any of the others.

The injection of a personal experience here might tell you more of what is meant.

I changed employers in 1926 partially with the understanding that, unless I was fired in the meantime, I would get a salary increase in six months. At the end of the period and in the face of a reorganization and merger, this supervisor sought the raise but received a turn-down from the vice president. At this point he prepared a recommendation for twice the amount of the first increase request and reopened the issue for the upwardly adjusted consideration. He took both of the records back into the vice president's office. After about thirty minutes, he returned in a happy mood, stating that the second recommendation was turned down but that the first one had been approved. Do you think my job interest was augmented by that situation? You are right. I did all I could do as a result of that support. How well do you support your subordinates? Do you take a chance with *you* in order to do so?

Some of you have had similar experiences, and they have made impressions on you too. They are about a supervisor who gave you a greater sense of dignity about your work, a greater feeling of security about your job, a greater degree of recognition, and also a greater satisfying degree of what is called "pride of accomplishment." When you did an especially good job, he let you know that he recognized it; and further he shared with you the praise he received from his own superior.

Some of you would say there is noth-

ing new about this information, and we whole-heartedly agree. Too, there is nothing new about calculus or the multiplication table or the Sermon On The Mount. Most of it is as old as civilization, and most of it is wound up in a little simple statement which you probably heard as a child from your mother, and it went something like this: "Son, if you want to have good neighbors, you must be one." One of the things new about it is that we are talking about it here, where up to now most of the conversations have been about the development of the amazingly wonderful discoveries in the physical sciences.

Thinking of you scientists and the progress of America industrially, we are reminded that one said of you that you could not open the day-coach window; so you just air-conditioned the entire train.

I have been listening to some of the technical papers at your API meetings. They remind me of the mathematics and statistics professor in the university who, one afternoon was standing dressed in his bathing suit at the edge of the campus swimming pool when a beautiful coed accidently dropped her camera into the deep end of the pool. She called to the elderly professor for help. He said he would be glad to dive after the camera but first wanted to know why she happened to choose him when there were so many young men within reach to do the job. She answered, "Professor, you have apparently forgotten me, but I am in your large statistics class. I have found that you can go down deeper, stay under longer, and come up drier than any one I know."

The industrial conflicts of our day are seldom for money, although it appears in the headlines to be the principal cause. They result when we fail to treat or we fail to be treated as decent human beings.

What would you say if you were asked how you could cause others to react more co-operatively toward you? If you were to be held strictly responsible for the satisfactory reaction of all other fellow workers toward you, what would you say? In too many instances, the answer is being given something like this, "Well, I would cause them to treat me better if I were to tell them something of my experiences so they could be helped in their work situation." Now think of it. Do you want someone to tell you that their way of doing things is better than yours? No! We don't want to be told! That's what's wrong now! We resent being told! We want to be asked! They will all like you better if you will but ask for help or advice. Did you ever refuse someone who asked your advice? No.! We think they are real smart just because they asked us. All other men, even our subordinates, are the same.

One speaker recently said, in emphasizing the importance of people getting along with people, that the Russians took Bulgaria with Bulgarians, that they took Czechoslovakia with Czechoslovakians, and that they took Red China with permissive Chinese. He

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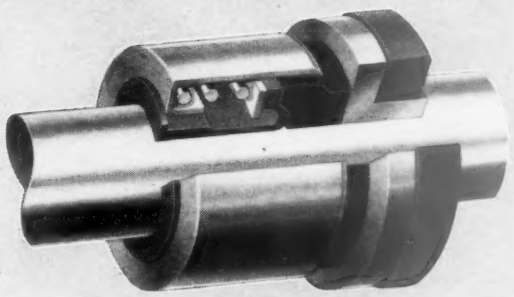

Type BB-21A—Garlock Package Seal of standard construction with brass shell, brass washer, and Buna-N bellows.

	TYPE BB-21A	TYPE AA-21A
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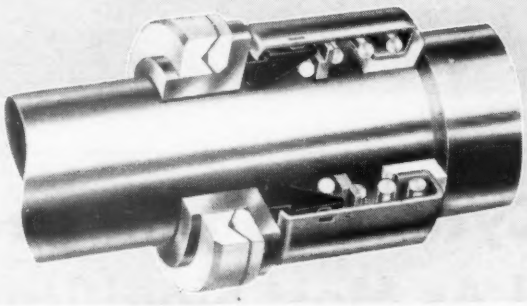
Equipment	Rotating shafts of centrifugal pumps, process pumps, chemical pumps, agitators and similar applications.	
Sizes	For shafts from ⅜" to 3" diameters.	
Temperatures	With Buna-N bellows up to 212°; with silicone bellows up to 450° F.	Up to 450° F.
Pressures	Up to 150 p.s.i.	Up to 150 p.s.i.



Type AA-21A—Garlock Package Seal with hat-shaped "Teflon" drive ring, brass or 316 stainless steel shell and washer, "Teflon" 'O' ring, and "Teflon" two-piece vibration ring.

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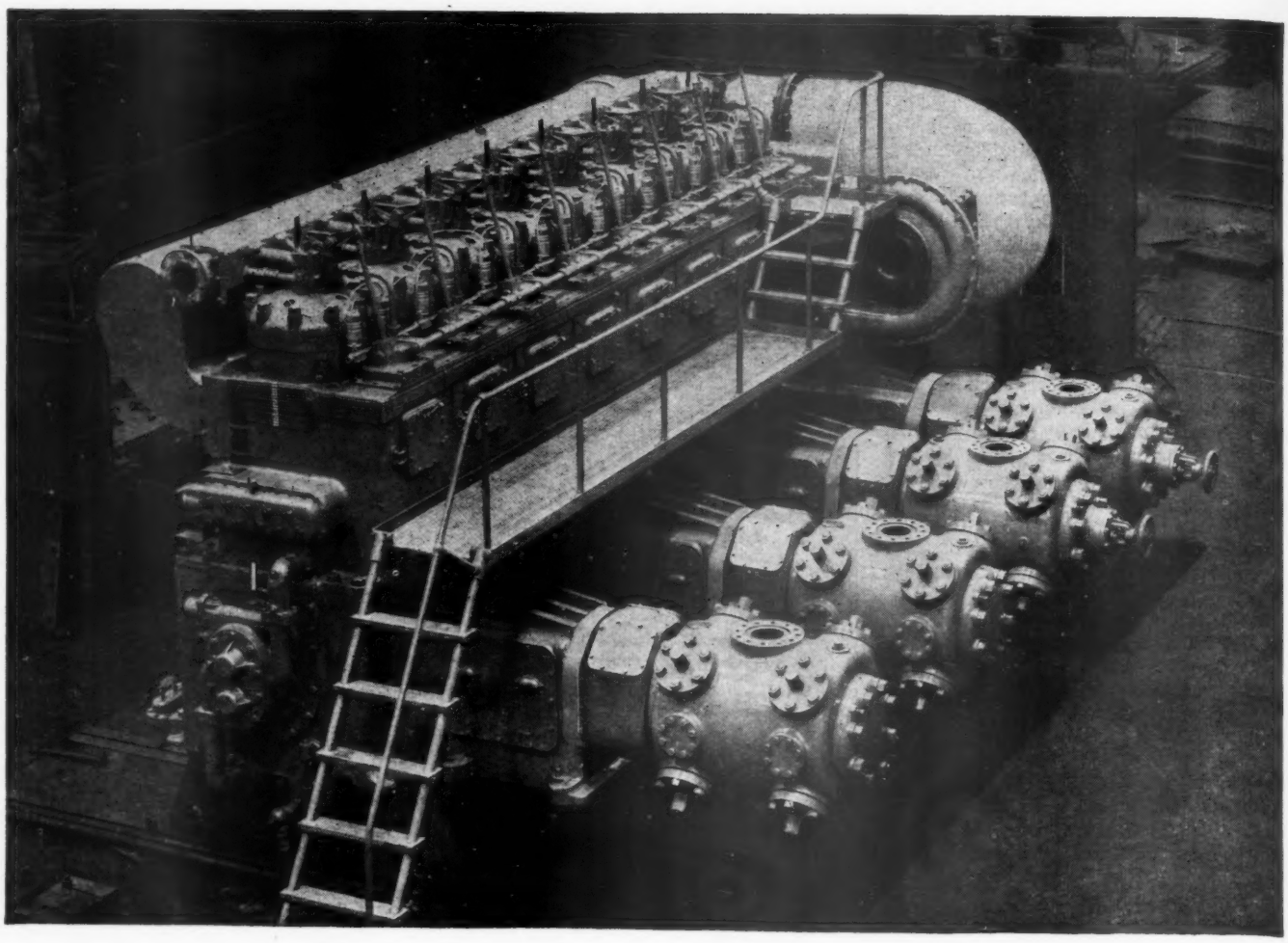


Clark 2-Cycle Turbocharged "Right Angle" Heralded As Most Significant Development In Compressor History

Revolutionary changes in gas-engine-driven compressor design set new records for power (50% increase), fuel economy (10-15% decrease) and cooling water load (25% decrease)

THE recently developed Clark 2-Cycle Turbocharged Right Angle Compressor has set new, industry-wide standards for power and operating economies, reports Clark Bros. Co., Olean, N. Y.

Climaxing an intensive 7-year Clark development program, the availability today of this completely new, turbocharged compressor design provides the realistic and ready answer to increasing cost of gas, inadequate cooling water supply in certain areas and the need for more powerful, more compact units. Clark engineers list the following points in support of these claims:

50% More Power

Fifty percent (50%) more power is delivered than by any previously built non-turbocharged unit of comparable bore and stroke (without any encroachment on overload carrying ability). The stepped-up power output means reduced building, foundation, piping and maintenance costs as well as decreased operating personnel.

10-15% Less Fuel Consumed

Conservatively rated, the new Clark unit is guaranteed to burn 10 to 15% less fuel than the best non-turbocharged, high compression, gas-engine-driven compressor previously built.

25% Less Cooling Water Load

Cooling water requirements per bhp are twenty-five percent (25%) less than those of the best non-turbocharged, high compression, gas-engine compressor previously built (including scavenging air

(Advertisement)

intercooling duty). This is important not only in arid locations, but means fewer cooling towers, smaller pumps, smaller piping and smaller motors to drive water pumps.

Flat Fuel Consumption Curve

Fuel consumption remains practically constant between seventy percent (70%) of load and maximum load, assuring optimum fuel economy over the entire operating range.

Quiet Operation

Energy, formerly lost in noise, is now harnessed for useful work by the Clark Turbocharger. This, plus a fully insulated exhaust manifold and en bloc construction, make it the quietest, smoothest operating gas-engine-driven compressor ever built. There are no exhaust pulsations.

UNITIZED, MATCHED DESIGN

Both turbocharger and compressor were designed and built by Clark as matching components. The result, say Clark engineers, is a highly efficient, unitized and integrated design.

The Turbocharger

The Clark turbocharger combines many of the design principles of Clark radial inflow turbines, combustion gas turbines and centrifugal compressors.

As applied to the new Clark Compressor, turbocharging is a practical means of converting waste heat into energy. It utilizes the waste heat, velocity and mass flow of the exhaust gases to drive a radial inflow turbine. The turbine, in turn, is integrally connected to a centrifugal compressor impellor which pumps air to scavenge the power cylinders and to furnish air for combustion. No scavenging cylinders are used or required.

At start-up and on light loads, the turbocharger is direct driven through a gear train from the engine crankshaft. Under all other load conditions, the turbocharger operates independently of the engine, its speed automatically conforming to the load placed on the engine.

Because the Clark turbocharger operates at very conservative speeds and temperatures, no critical, scarce materials are required for its construction.

The Compressor

While the gas-engine-driven compressor is an entirely new unit, specially designed to match the characteristics of the new Clark turbocharger, it retains many of the basic Clark "Angle" design features. Clark engineers describe it as the most rugged compressor ever built, "with a very conservative BMEP rating for a unit of its proportions."

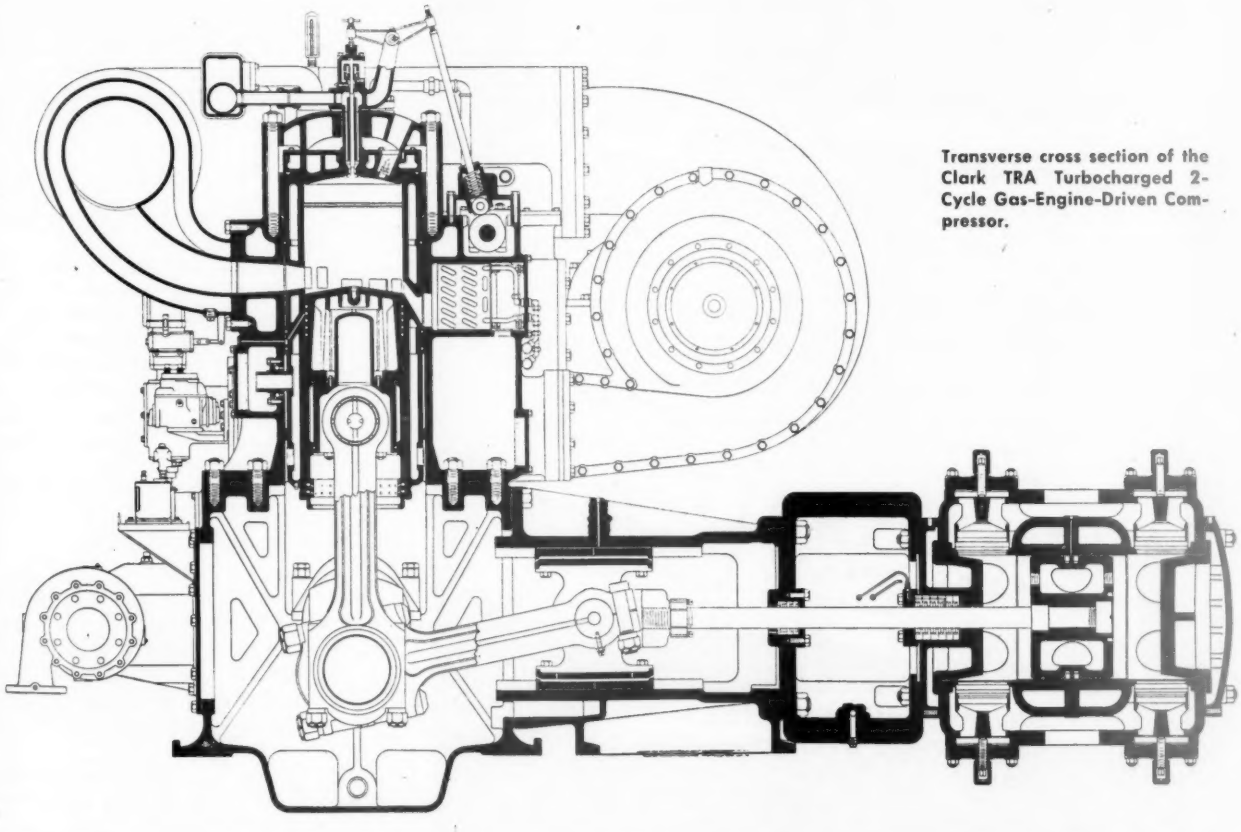
Following a long established Clark practice, the new compressor is an extremely compact, yet highly accessible 2-cycle, in-line design. It occupies considerably less space per bhp than non-turbo-charged units, because of its increased power output. Featured are: Cylinder block construction with removable power cylinder liners; full precision bearings; one-piece forged steel crankshaft; oil-cooled power piston heads and skirts; heavy, forged steel connecting rods; fully insulated, streamlined exhaust system.

MODELS

The Clark Model TRA-8, illustrated, has eight vertical in-line power cylinders of 14″ bore and 14″ stroke, developing 1320 bhp. Other size turbocharged units also are available.

Bulletin 130, with complete information on the Clark 2-Cycle Turbocharged Gas-Engine-Driven Compressor is obtainable from Clark Bros. Co., Division of Dresser Operations, Inc., Olean, N. Y.

Clark manufactures a complete line of heavy duty compressors: motor driven; gas, steam and Diesel engine driven; centrifugal and axial flow.



Transverse cross section of the Clark TRA Turbocharged 2-Cycle Gas-Engine-Driven Compressor.

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also said that if they take America they will do it with Americans and not with armed forces. What are we as industrial Americans being permissive toward? Are we going to wrangle, fight, resent, and repulse each other, even members of our own team, within our own work situation to such an extent that our overall production will be too little to meet the needs which we must have; or are we going to find out the causes of these very corrupting situations and eliminate them from our individual thinking and activity? If we do the latter, who is going to have to bear the burden of its doing? The answer to that is "our industrial supervisors." They carry the ball. In order for the men to be loyal to them in or out of the work situation, they first must deserve and attract such loyalty by their own words and acts. What is more, we had better help them so that their mistakes will be few because our jobs depend upon them being right in their judgment. After all, the boss is only telling us what we must do in order to satisfy our customers; and we should never doubt that the power behind the boss is the customer.

Our supervisors have the most comprehensive, complex, and difficult assignment in our whole way of life. They must collaborate all of the technical and skilled human efforts in their respective groups so as to transform the entire experience of those groups into a power usable in their own job situations. In doing this, the opinion of the subordinate is often sought in a wholesome manner, and the superior is not just spending his time holding the helm. In doing this, too, he is assembling all of the knowledge and skill of his group, which may be usable in his own work situation. Ask your subordinates for their opinion. They will like you better for the opportunity, and besides you may really learn something. Some of you know this better than I, but should not all supervisors know and use it?

Now if we get down to tasks, what should we look for in this self-awareness program? Some of you will say, "I shall first look for the wishes of the boss." If you do, you are quite right, because all of the rest of us will do the same thing regardless of what our academic thinking may suggest. That reasoning, of course, explains why it is important that any program of this type, if it is to be successful, must begin with the boss, not only that he might give it sanction or acquiescence with words but that he might be its model for our guidance. The rest of us must see him use it in his daily contacts with us in order for us to use it, too, with our subordinates.

In addition to imaging the boss, however, there are many guides. A very great many thousands of words have been written about supervisory development and training as the word is used in a general sense. We have had time to study a small portion of the formal records, and we have found it to be a privilege and a pleasure to look into the works of such persons as the following, who have made the record only after having first participated in careful research practice and observation: M. L. Mace, A. Zaleznik, Ordway Tead, A. R. Heron, Henry C. Metcalf, L. Urwick, F. J. Roethlisberger, Mary Parker Follett, and Chester I. Barnard. Then, too, there are such practitioners as H. W. Heinrich of The Travelers Insurance Company, M. L. Powers of Oklahoma University, and M. L. Barlow of UCLA, from whom we have received help on the subject.

What specifically shall we look for in this program? One says we should look for attitude, ability, knowledge, and action. Perhaps we can agree with this because, under attitude, we find the following four interesting segments:

1. Willingness to lead and direct.
2. Recognition of responsibility to employer.
3. Recognition of responsibility to employees.
4. A sense of fair play.

Perhaps we can agree with it, too, because under ability we find four other segments which are:

1. Ability to plan and organize.
2. Ability to train and instruct.
3. Ability to observe and analyze.
4. Ability to persuade, convice, and command.

Perhaps we can also agree that knowledge is one of the objects of our search because under it there are:

1. Knowledge of company policy.

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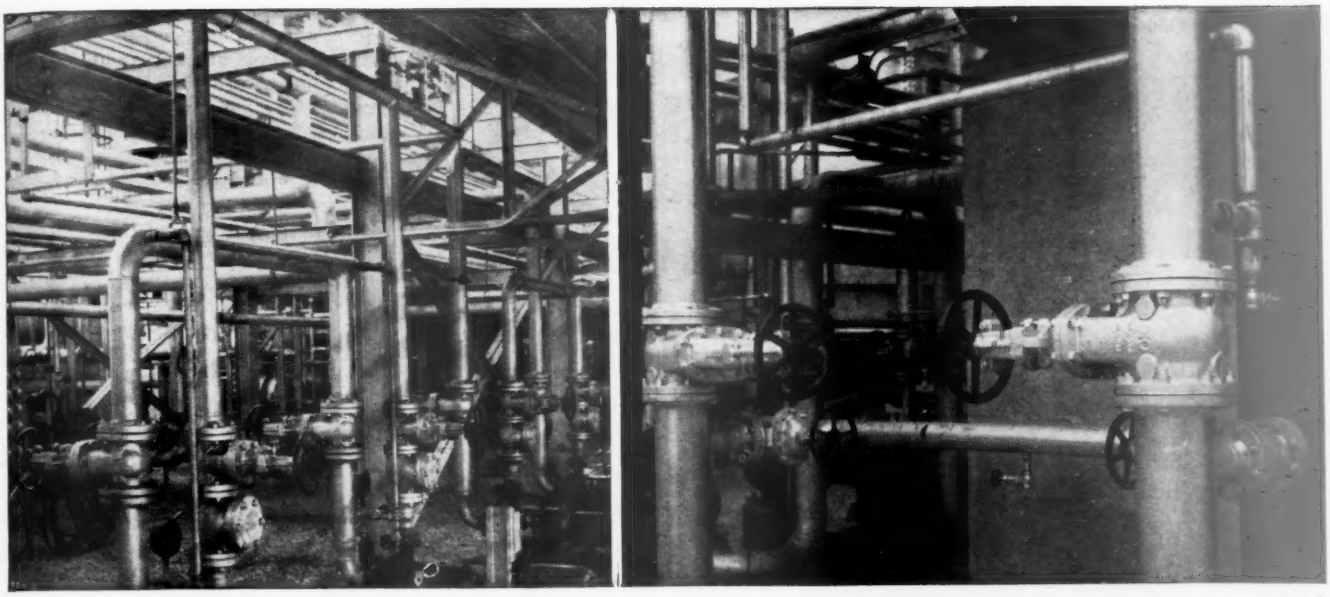

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XUM

2. Knowledge of right and wrong job conditions.
3. Knowledge of human relations and of right and wrong employee practices.
4. Knowledge of control methods.

Now, of course, it is admitted that by merely having attitude, ability, and knowledge, we cannot reach the pinnacle of being a supervisor, because there is no action present; so then perhaps we should look within ourselves to see what sort of action we find. Do we have the inside drive to:

1. Actually train and instruct.
2. Actually give the orders.
3. Check work performance.
4. Establish preventive and corrective measures.

We may apply these criteria as best might fit our experience. For example, what do we individually think of ourselves relative to having a distinct willingness to lead and direct other people's activities? Would we really be better off if we were to be permitted the uninterrupted sanctuary of our own private office without having to make personal contacts? We can decide this for ourselves.

Then, too, do we really have a desire to express a sincere responsibility to our employer or to acknowledge sincerely the good work of a subordinate?

How about this ability relative to a sense of fair play? Have you ever had a supervisor whom you thought may have had the question within himself as to whether he should ever really be fair with his subordinates, or would his sense of fairness outshine his desire to protect himself from the criticism of his supervisors? To this extent, are we really aware that careless treatment of subordinates by a careless supervisor has actually caused most of the Communistic planting and growth in the minds of our workers where such thinking exists?

It is not necessary for us to spread words here for further guidance of thought in all of these avenues but let's take a closer look at this ability to persuade, convince, and command. In our experience, it is possible that most of our supervisors, or at least some of them, have merely commanded us rather than given any effort at persuading and convincing us before they issue the command? How have we reacted to that situation? Could we assume that our own subordinates have the same reaction to our own careless way of doing it?

One of the recognized thinkers in industrial psychology was Mary Parker Follett, who up to the time of her death in 1933, spent 10 active years lecturing to top industrialists of the world. She found that there was a procedure whereby orders could be so given that no personal feeling of resentment could possibly result. She said that situation comes about when a supervisor assembles his group and encourages discussions by each of its members of the job circumstances in such complete and impersonal manner that, upon finishing such discussions and summarization by the leader, the *situation and not a person gives the instructions in each direction*. Each member of the group, therefore, has his opportunity to contribute. The alert supervisor's summation gives credit for all contributions and makes each participant feel that his words became a part of the instruction given off by the situation.

This may sound like great involvement, and it will consume time and energy not previously used; but can anyone question that it would help solve these terrific industrial strifes of our day? Does not our type of democracy require teamwork on the part of:

1. Capital.
2. Management.
3. Labor.

Might this not be one of the guides through which such teamwork can be had?

Now how about this action of training and instructing? Are we really aware that we individually are only as strong and no stronger than we permit and train our subordinates to be?

Surely we may ignore all of this thing as it applies to us and continue as some of us have done in the past to think of it only as it applies to the other fellow; but if we do, should we anticipate any greater accomplishments than we individually have had, and should we expect a continued improvement in our way of life? If so, what might happen to our government? Is it possible that

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we might slip back into the autocratic planned and controlled way of life, where there is no capitalism, no free enterprise, and no democracy?

Do we as a member of our bosses' group enjoy the opportunity of participating in the thinking and planning about our work? Could it be that our subordinates feel the same way about the situation? Which gives you a greater dignity and sense of belonging, to participate or not to do so?

One man has said:

"I never clash with my boss.

"No?

"No, he goes his way, and I go his."

Another one of our leaders on the subject suggests the following qualifications and order for a supervisor or leader of men:

1. Vitality and endurance.
2. Decisiveness.
3. Persuasiveness.
4. Responsibility.
5. Intellectual capacity.

These might be worthy of individual study and contemplation. I know one who, in the beginning, did not agree with the order but thought that intellectual capacity and responsibility should be at the top of the list. C. I. Bernard, president of the Rockefeller Foundation and former president of the New Jersey Bell Telephone Company is the author of this list of qualifications. Further he said:

"The democratic process either in government or in innumerable other organizations in which it may be used *depends* upon leaders strong enough to maintain their ambition under its perplexities, patient to endure its restraints, proud to be foremost among the free, humbly loyal to the humble, wise enough to seek service above the illusions of power and the futilities of fame, willing to be briefly spent in the long span of marching events."

He further says that it might be well that we are warned of the dilemmas of the democratic process so that we might see the great challenge and the wider meaning of the service of leadership which democracy has given us in America.

Still another one of these thinkers and advisers, Ordway Tead of Columbia University, on the subject says it this way:

"Where friendly appeals are made by congenial and trusted leaders, where attractiveness and importance of group goals are made clear, where group pride is built up, where the personal stake of each person in the groups' outcome is clearly grasped by all, where the leader has a personal concern and solicitude for the integrity and promise of each member of his group, and where this whole body of conditions is being realized, the resulting group behavior will be productive and happy to an optimum degree."

If you are a supervisor, then be one about whom someone may some day say at your retirement party, "I would rather have worked for him than for any of the others."

* * *

Department of the Army

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Converts coal to synthetic liquid fuel in two major operations: (1) liquid-phase hydrogenation, which accomplishes liquefaction of the coal; and (2) vapor-phase hydrogenation, which converts the liquefied coal to gasoline and by-products such as naphthalene, tetraline, benzene, cyclohexane, zylene, toluene and ethyl benzene. Throughput of 60 to 80 tons of coal provides daily output of 200 to 300 barrels of liquid fuel.

GAS SYNTHESIS PLANT

Provides facilities for the complete gasification of approximately 20 tons of coal per day to produce a carbon monoxide-hydrogen mixture which is used in the synthesis of hydrocarbon by the Fischer-Tropsch process. Capacity: 40 to 80 barrels of liquid fuels a day and, in addition, by-products.

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Detailed information, arrangements for inspection and proposal forms may be obtained from the Division Engineer, Missouri River Division, Corps of Engineers, P.O. Box 1216, Omaha, Nebraska.

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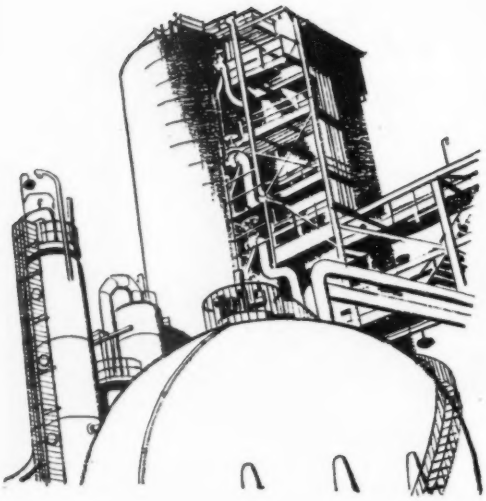
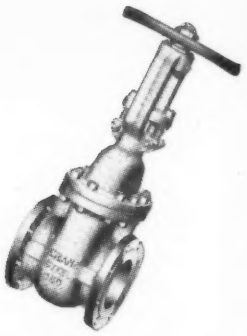
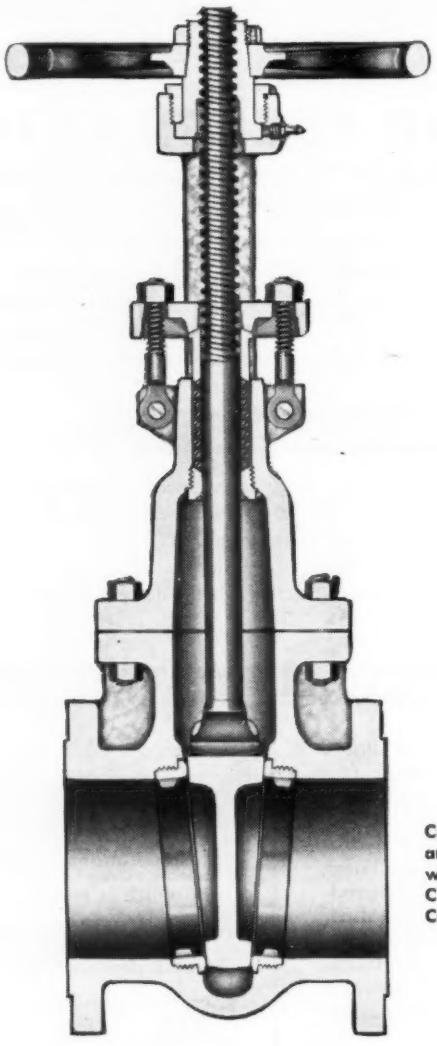




Workhorse of the Oil Industry

CRANE 150-POUND STEEL GATE VALVES



In every industry there's one outstanding valve that bears the brunt of service. In petroleum, it's the 150-pound cast steel wedge gate. As a pioneer in its development, Crane is proud to have helped set the high quality standards of modern steel valve design.

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The movement illustrated here represents just one way—but a very important way—in which the Mastergauge excels. In a pressure gauge, the movement has the vital assignment of converting the action of the bourdon tube into accurate pressure indication. To do this unfailingly, a movement must be ruggedly constructed, practically frictionless and highly resistant to corrosion.

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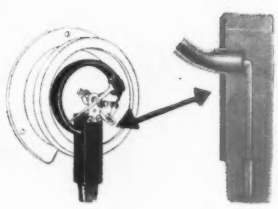
Yes, features like these, along with precision machining, painstaking assembly, and thoroughgoing testing, makes a better-in-all-ways movement for a better-in-all-ways gauge. Ask for up-to-the-minute information.



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BOOKS

▸ **Measurement Techniques in Mechanical Engineering** *by R. J. Sweeney. Published by John Wiley and Sons, 440 Fourth Avenue, New York 16, New York. Pages, 309. Price, $5.50.*

A practical source of information on the techniques commonly used in the testing of power equipment, the book covers the principals that underlie the operation of pumps, engines and compressors. It also discusses combustion and heat transfer apparatus and emphasizes the application of the theory of testing to the problems met in the practice of the work. Designed for both the student and the practicing engineer, it explains the principals of instrumentation and the fundamentals of design and points out the difficulties involved in obtaining a correct measurement of physical properties.

▸ **Chemical Process Machinery,** *by E. Raymond Riegel; Second Edition; Reinhold Publishing Corporation, 330 West 42nd Street, New York. Price, $12.50. Pages, 735.*

This second edition of an original work published first in 1944, as its author states in preface "is meant to be an exhibit of the devices which are obtainable in the open market." It discusses these various items of chemical processing equipment in a series of chapters covering the entire industry.

For petroleum refining and petrochemical technologists and engineers the chapters on:

"Devices for Propelling and Elevating Liquids";
"Distilling and Fractionating Equipment";
"Equipment for the Propulsion of Gases";
"Vacuum-Producing Devices";
"Heat Exchangers";
"High Pressure Equipment";
and "Instrumentation (Three Parts)," are of special interest. On heat exchangers the author discusses the several conventional types, gives some mathematics for calculating capacities, etc., and also mentions some more modern units such as the Tubeflo, the spiral type, and multiple units. Instrumentation is discussed in some detail, both the theories and principles on which different units are designed, and covers with a reasonable amount of data all types of temperature and flow measurements, rotameters, piston and impeller types. The author devotes the entire last chapter to discussing the intricacies and applications of automatic controls.

▸ **Five Star Oil Report's "District 7-C Book,"** *edited and written by J. Frank Gardner and Robert L. Phifer. Published by Five Star Oil Report, Inc., Houston, Texas. Price $25, to subscribers, $35 to non-subscribers.*

Contained in the new book is a complete abstract of all oil and gas fields in Railroad Commission, District 7-C, West Texas. Included is a compilation of field data, accompanied by a multitude of structure maps and cross sections and special articles on the most promising area in Texas for future oil exploration.

▸ **Mechanical Engineering Thermodynamics,** *David A. Mooney; Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, New York. Price, $9.35. Pages, 540.*

Written by a mechanical engineer of very long experience, this volume covers thoroughly basic principles of thermodynamics and application of this science to mechanical engineering processes. Gases and vapors are not treated as two separate subjects but are included under the same treatment. The book covers vapor cycles, gas cycles, combustion processes, refrigeration, turbines, and the first two laws of thermodynamics in a very comprehensive manner. More than 230 examples are given, to teach specifically as many individual points of application. Application is discussed in greater detail than is normal in such works. The author was formerly a professor of mechanical engineering at M.I.T., chief engineer of the battlewagon "North Carolina" during World War II, and is now chief mechanical engineer with the Boston engineering firm Jackson and Moreland.

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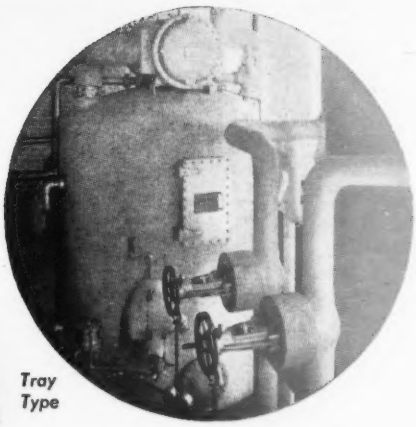

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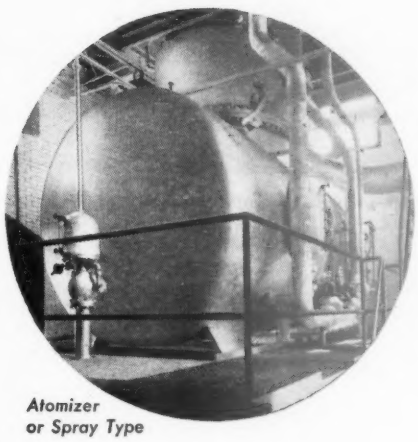

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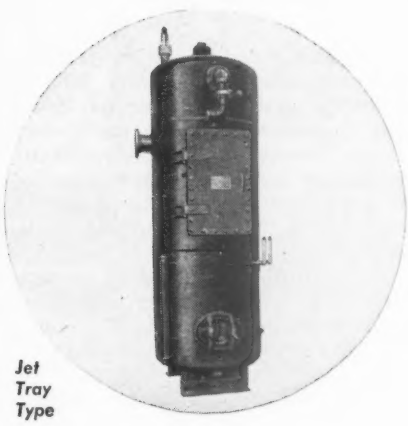

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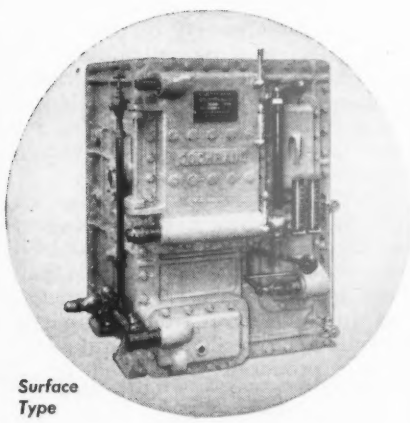


Surface Type

PRODUCTION pumper Vernon Wright looks over the Magnolia Petroleum Company Northwest extension, Burkburnett field water flood pump station which he operates. Magnolia's development of a fluid injection program in Wichita County has greatly increased the company's daily oil production in North Texas.

PUMPER S. M. Butts, foreman J. A. Durham, and assistant foreman Robert Crowder do some paper work before tank battery on 160-acre J. G. Goins lease in West Burkburnett field. Magnolia introduced a fluid injection program which has allowed company to run almost a million barrels of secondary recovery oil through these tanks.

Magnolia Plans Expansion of North Texas Operations

Increased crude oil production through a secondary recovery, fluid injection program by Magnolia Petroleum Company on leases in the Wichita County, Texas, area has prompted improvements and new construction on the company's North Texas properties, according to J. L. Latimer, Magnolia president.

"Successful water flooding projects in Wichita County have helped increase crude production in Magnolia's Electra district from an average of 2808 bbl of oil daily in August, 1948, to 9747 bbl a day during August, 1953," Latimer said.

Nine years ago the company began experimenting with a pilot water flood on the 160-acre J. G. Goins lease in the West Burkburnett oil field. The water injection program adopted by Magnolia petroleum engineers raised the lease's production from 53 bbl of oil a day up to a peak of 900 bbl a day —an increase of nearly seventeen times.

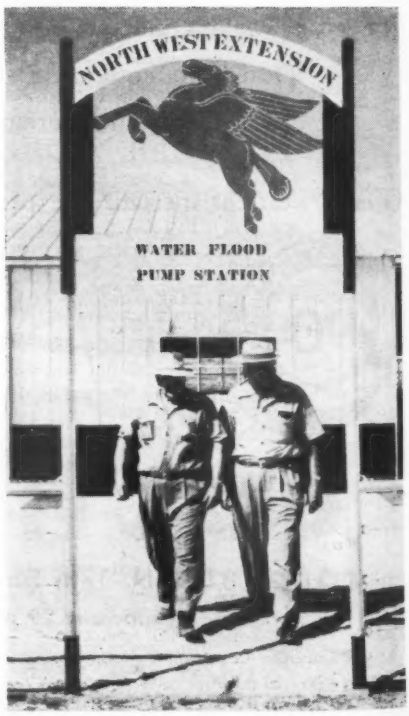
"The fluid injection project on the Goins property has been so successful that Magnolia has produced more oil from secondary recovery methods than it did from primary recovery operations. In the 31 years from the time of the fields discovery in 1913 until 1944, the lease produced 629,673 bbl of oil by primary recovery. Secondary recovery production since 1944 has amounted to nearly a million barrels," Latimer pointed out.

Based on the success of the Goins lease, Magnolia began extending its fluid injection program in the area in 1949, until today gradual expansion through new drilling has enlarged the known extent of the reservoir in the West Burkburnett flood project to some 2127 acres.

"At the present time Magnolia has five other Wichita County water flooding projects under development. Because of the nature of fluid injection operations, it will take several years before we can expect our production from these projects to be substantially increased," Latimer added.

In major expansion moves, Magnolia is constructing a new office building in Electra, Texas; is expanding its Burkburnett gasoline plant, and the Magnolia Pipe Line Company is building a new, 16-in. crude line from Ringgold, Texas, to Corsicana.

To help transport the increased production from the North Texas and Oklahoma areas, Magnolia Pipe Line Company is replacing its 154-mile multiple 8-in. system and pumping equipment between Ringgold and Corsicana with a new 16-in. line. Construction work on the new line is under way now in two sections. One section is being built northward from Corsicana, and the second is being advanced to-



PRODUCTION foreman H. W. Shields, and assistant foreman C. E. Lundberg leave one of their company's newest water flood pump stations in the Northwest extension, Burkburnett oil field. Magnolia has been a pioneer in developing water flooding projects in this area.

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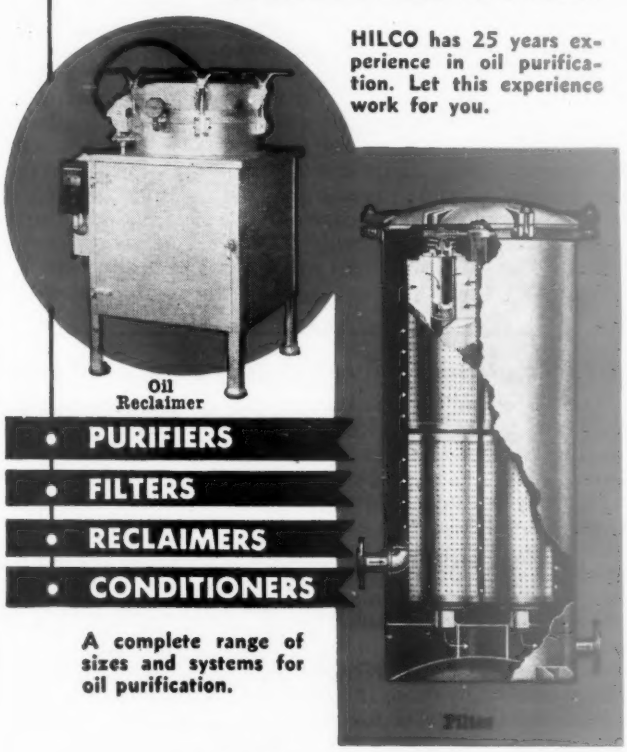

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MAGNOLIA Petroleum Company's C. Schmoker lease in the West Burkburnett oil field is included in the Dallas company's water flooding program. Here production pumper Lee Bridges gages one of four 1000-bbl tanks.

BECAUSE of increased production from its water flood project in the West Burkburnett oil field, Magnolia Petroleum Company has been replacing its old pumping equipment with these modern, electric driven pumping units.

ward Ringgold from Keller, Texas, near Fort Worth.

The pipe line company is also erecting a new, all-electric main line pump station at Ringgold. Contractors have already built the station house and have poured the pump foundations. When finished the new station will have completely modern pipe line features, including metering equipment to measure incoming crude, motor-operated gate valves and remote control tank gaging equipment. Company officials estimate that the new system will be in operation by January 1.

In Electra, Magnolia is erecting a new building scheduled to be the company's largest district producing office. The building will house 21 offices and will be completely air conditioned for summer and winter. Contractors are now framing the new structure which should be finished in December 1953.

In addition to these new construction projects, Magnolia is enlarging its Burkburnett gasoline plant to increase the plant's capacity to 1,275,000 cu ft of gas per day. Additional gas from the Burkburnett Townsite and the Ramming projects.

PEPA Holding Silver Anniversary Meeting

The Petroleum Electric Power Association is holding its 25th aniversary meeting at the Muelebach Hotel in Kansas City, Missouri, October 5-6-7.

PEPA was founded 25 years ago in Kansas City by a group of oil and utility men who wished to share their problems and knowledge of electric power in producing, refining, and pipelining of oil. An outstanding group of speakers are on hand to present papers in these fields and discuss related problems presented by those in attendance.

With the addition of five new member companies this year the Association is planning an expanded program to match the trend of electrification in the oil industry.

Papers being given include: "Twenty-Five Year Growth of the use of Purchased Electric Power in the Petroleum Industry," Mitchell Tucker, *Oil and Gas Journal;* "Power Distribution Trends in a Refining Industry," W. B. Wilson, General Electric Company; "Electric Motor Design and Proper Application in the Oil and Gas Industry," Edward F. Griewe, Allis-Chalmers; "Economics and Experience with Purchased Power in a Refinery," T. R. Shaw, Phillips Petroleum; "Description of Automatic Controlled Pumping Stations," Fred S. Jones, Platte Pipe Line; "Your Electric Service—There's Much Behind the Flip of Your Switch," C. Myron Lytle, Kansas City Power and Light; "Electrical Design of Pipe Line Pumping Stations for Safety Under Hazardous Atmospheric Conditions," Merritt Hyde, Westinghouse Electric; "Electric Power for Products Pipe Line Pumping," P. R. Madden, Great Lakes Pipe Line, and "New Technique in Oil Production," Ralph Spearow, The Spearow Company.

Meeting Dates Announced

The American Welding Society announces that it will hold its 1954 National Spring technical meeting in the Hotel Statler at Buffalo, New York, Tuesday through Friday, May 4-7, 1954. The Society headquarters hotel will be the Statler, with guest occupancy at all other leading Buffalo hotels.

The Society also announces that it will hold its 1954 Welding and Allied Industry Exposition in the Buffalo Memorial Auditorium, at Buffalo, New York, Wednesday through Saturday, May 5-8, 1954.

World Oil Output Down In February, B of M Reports

World crude production in February, averaging 12,785,000 bbl daily, was off slightly from the January figure of 12,816,000. Among the principal producing regions, the Middle East output in February reached a record daily average of 2,308,000 bbl, despite a slight decline in Iraq and Kuwait. Saudi Arabian production averaged 792,000 bbl daily compared to 781,000 in January. In Venezuela, daily average production, 1,717,000 bbl, declined 4.2 per cent. Production in the United States increased slightly on the daily basis.

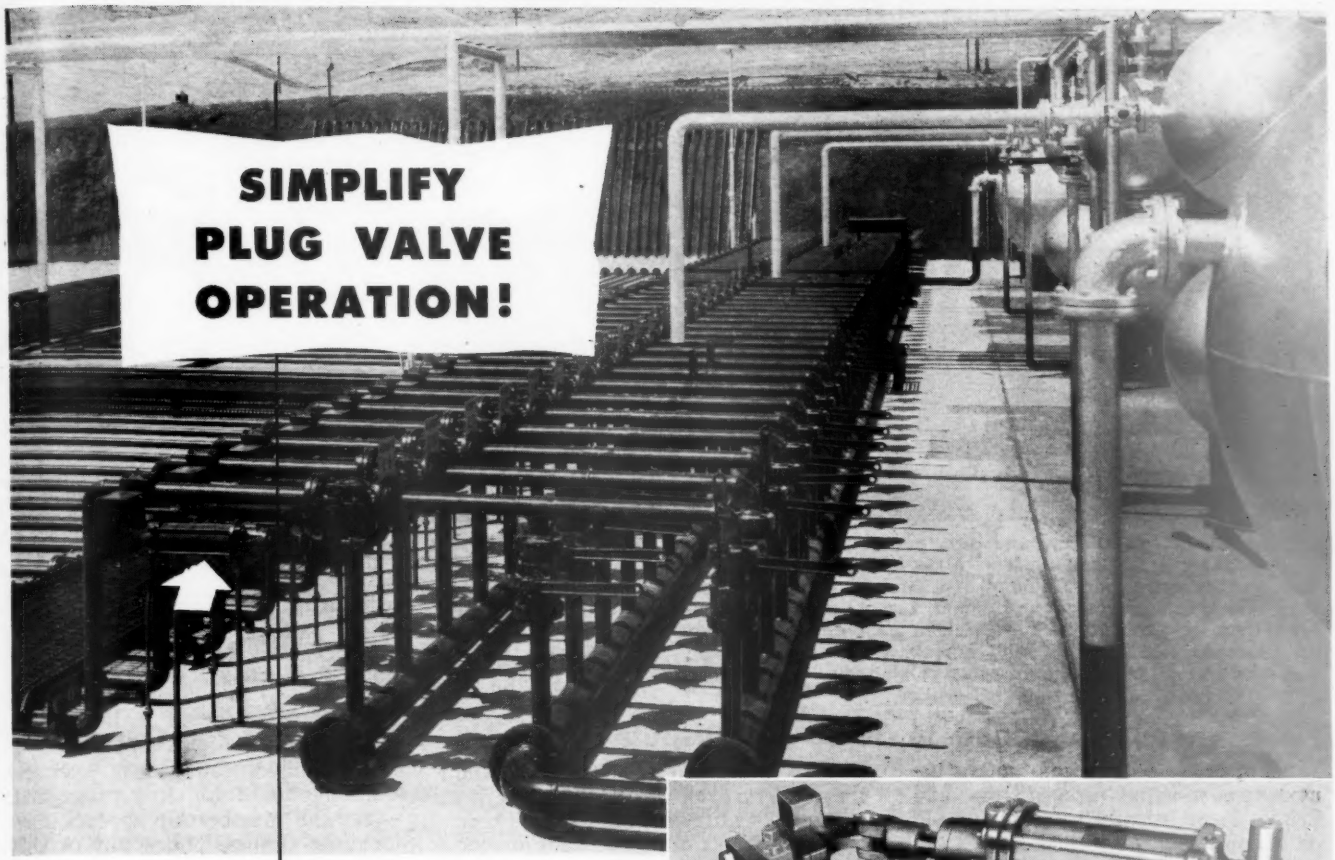
Crude imports into western Europe averaged 1,374,000 bbl daily in February, a decline of 4.3 per cent. Although French imports reached a record 465,000 bbl daily in February, declines occurred in imports by Italy (2.7 per cent), Netherlands (37.5) and United Kingdom (6.2).

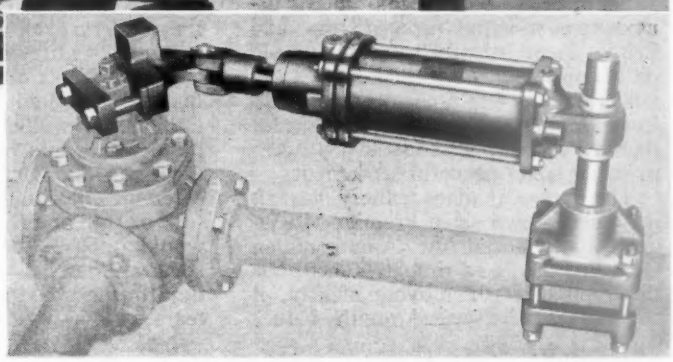
Oil Films Deny Monoply

Denials of monoply have been filed in the government civil antitrust suit by oil companies accused of conspiring to engage in an international cartel to monopolize trade and keep petroleum prices high.

Socony-Vacuum Oil Company, Inc., said that rather than hampering oil trade it had contributed to its development. Standard of New Jersey declared that its operations were performed in the local commerce of foreign nations or in commerce between such foreign nations. Gulf made a denial of charges.

DELEGATES arrive in Denver for the second annual Desk and Derrick convention! Tommy Cross, Manco Corporation, Dallas, Texas; Faye Brannan, South Eastern Drilling Company, Dallas; Juanita Turner, East Texas Salt Water Disposal, Kilgore, Texas; Dorris Warren, Cody Oil Company, San Antonio, and Jammie Erwin, Newman Brothers Drilling, San Antonio.





The adaptability of the new Hanna Plug Valve Operator is shown in this application of a battery of Hanna units installed on Shell Oil Company's Brea Tank Farm in California.

The inset photo shows in bold outline the Hanna Valve Operator in a typical application.

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Fluid Power

Valve Operators

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- **Provides dependable, positive control**
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Hanna's new, low-cost packaged Plug Valve Operator power operates two-position, quarter-turn rotary plug valves. Because these compact units can be installed anywhere and in limited space areas, they eliminate manual control, reduce costly operating time. No more ladder climbing, long distance walking, wall scaling or disturbing flooring to turn valves on and off. With the new Hanna Fluid Power Plug Valve Operator, control is quick, convenient effortless. Installation is likewise simple. No special tools are required. A Hanna Engineer will be glad to show you how this new departure in valve operation can be adapted to your needs with profit.

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Operates with air, oil, water or petroleum gases.
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Simple and rugged—trouble-free operation.

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To obtain more information on products advertised see page E-63

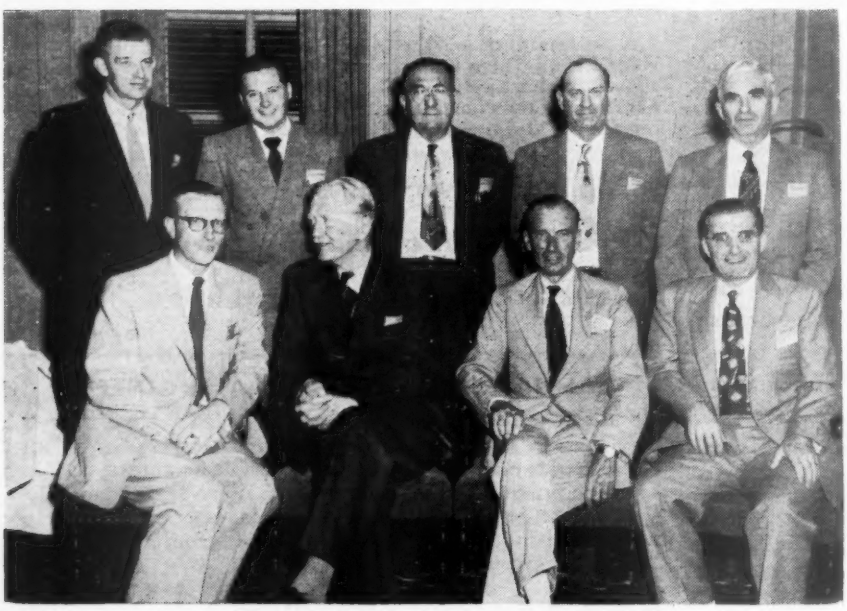
DESK and Derrick officers and directors elected September 9, 1953, at Denver. Seated officers: Mrs. Lorene Porter, Harold Herndon, secretary, San Antonio; Mrs. Meitzie Palmer, Vander-Leck and Whealton, 1st vice president, Los Angeles, California; Mrs. Irene S. Cox, Panhandle Producing Company, president, San Antonio, Texas; Mrs. Sybil Sureck, Union Oil Company, 2nd vice president, Oklahoma City, Oklahoma; Miss Angela Cross, Big Lake Oil Company, treasurer, Pittsburgh, Pennsylvania. Standing, regional directors: Bea Freyou, Oil Scout, Esso Standard Oil Company, Baton Rouge, Louisiana; Lydia Babka, Honolulu Oil, San Francisco; Betty Heaton, T. Cairns, Calgary; Elinore McAdam, Coastal Oil, Newark; Elouise Norris, Dooley Engineering, Oklahoma City; Dorothy Kassel, Kobe, Inc., Fort Worth, Texas; Minetta Miller, Ernest Baker, Denver.

New Attempts Planned to Settle Oil Dispute

New feelers will be put out in the next two months between Iran and Britian in an attempt to settle the old oil dispute. General Zahedi, new Iranian premier, disclosed in talks with Loy Henderson, U. S. Ambassador that his country is ready to try again to reach some peaceful settlement.

The large Abadan refinery has almost shut down since Premier Mossadegh nationalized the Anglo-Iranian Oil Company, and though Zehedi has the reputation of moving swiftly, it will probably be several months before some solution can be worked out and the refinery back in operation.

Another worry facing many oil men is that if Iran's oil is put back on the market, it would perhaps mean that the market would be flooded, and a price war would result. In New York, George Holton, chairman of Socony-Vacuum Oil Company, stated the return of Iranian oil to world oil markets would intensify competition, but "an industry that has thrived on competition through the years should have no fears of it now."



INTERNATIONAL GUESTS at the regular dinner meeting of the Los Angeles Chapter of Nomads are: (standing) Leo P. Le Bron of Kerr-McGee Oil Industries, Alaska; Roy K. Hautzinger of Baker Transworld, Canada; M. C. Womach of Kerr-McGee, Alaska; Marion C. Williams of Gulf, Kuwait; P. K. Ozinga ex-Shell, Venezuela. (Seated) Hans G. Goethe of Deutsche Erdoel A. G., Germany; Sir Robert H. Hadow, British consul general; Major C. Mott-Radclyffe, Member of Parliament, England; R. T. Myers, United Overseas Petroleum Company.

D & D Ends 2nd Convention

The United Nations has become a sounding board for Red propaganda — and our membership appears to endorse the Godless philosophy of U.N. activities, was the theme of Bernard L. Majewski's talk at the final banquet for oil women at their second annual convention in Denver. The president of Great American Oil Company called on the 1000 members of Desk and Derrick Clubs present to fight the trend toward cynical acceptance of expediency in world affairs. Majewski was introduced by 1953 president, Miss Margaret Neff.

Highlights of the convention, September 11 and 12, was a surprise visit of Vice President Nixon, welcoming speeches by Governor Dan Thornton, and Mayor Quigg Newton, keynote address by Mrs. Lee Wilson Hoover, and first president of the organization. Canada's oil and its tremendous expansion was told by N. E. Tanner, president of Merrill Petroleums, Ltd., of Calgary.

New officers were elected (see picture above) and well prepared group programs used the panel system to discuss problems that arise in pursuit of the clubs' objectives of greater knowledge and greater service.

Vela Pendleton was named winner of a feature contest conducted by the club. Her article was entitled "'A Panorama of the Duncan Desk and Derrick Oil Country." She is employed by Halliburton Oil Well Cementing Company. Other winners were Suzanne Erickson, Gulf Research and Development, second prize, and Winnie Van Arsdel, Carter Oil Company won third prize.

Meeting place for the convention in 1954 is Calgary, Canada, and will be held in the Banff Hotel some time in September.

Management Papers Published

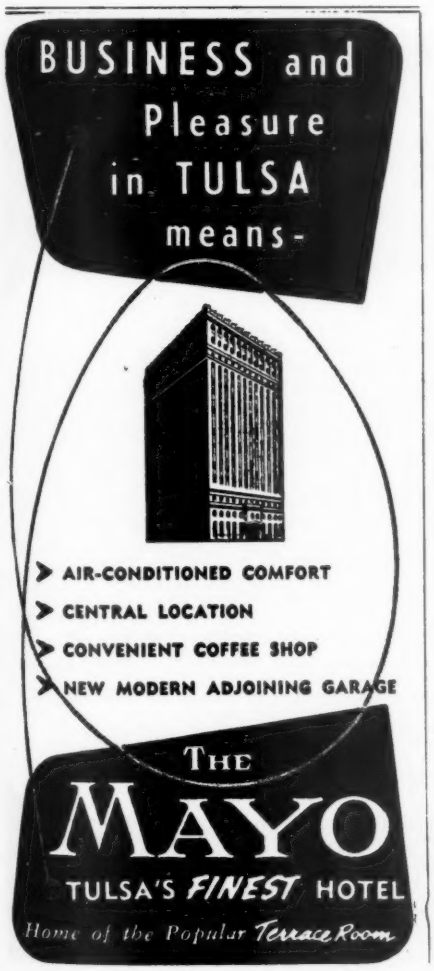
The Consolidated Reporting Company of New York City has published a new booklet entitled "1953 Industrial Management Symposium." It is a collection of papers on management and its relationship to employees. Included in the papers is an article "Applied Psychology and Management" written by Arch L. Foster, editor, Refining and Petrochemical Edition of *The Petroleum Engineer*.

API Withdraws Approval Of 1936 Standard Tables

In an action that will affect thousands of contracts, the American Petroleum Institute announced that it is withdrawing its approval of the National Standard Petroleum Oil Tables issued in 1936.

The Institute said that the American Society for Testing Materials and the Institute of Petroleum has published a volume of recalculated and extended Petroleum Measurement Tables, and that it is endorsing these as the new national standards.

Approval of the change was voted by the Executive Committee of the API Board of Directors at a meeting in White Sulphur Springs, West Virginia. The action was taken at this time to give the industry as much advance notice as possible for substitution of the tables in regulations, tariffs and contracts.



Jap Barter Plans Falls Through in Iran

With the overthrow of Mohammed Mossadegh in Iran, Japan is said to have lost its chances of negotiating a "skill-for-oil" trade. The report was made by British oil men, who suggested that Japanese technicians should give the Iranians assistance in extracting and refining oil in return for refined products at "special prices."

In preparation for the trade, the Japanese had begun building one of the world's largest tankers, one of a fleet to haul the Iranian oil. They also admitted that "a fraction of one day's full operation at Abadan would meet our oil requirements for weeks."

Meantime, a tanker loaded with 119,000 bbl of Iranian oil and gasoline has reached Tokyo, the third shipload imported by the Idemitsu Kosan Company.

Oil Women Hold Seminar

The University of Oklahoma was scene of a seminar for oil women of the Midwest this month. A 2-day meeting was arranged by the Oklahoma City Desk and Derrick Club, and was the first informational and educational program of its type undertaken by a Desk and Derrick Club, according to Clarice Anderson, president of the Oklahoma City club.

Meeting covered geology engineering and proceedings for meetings of oil industry personnel, and laws of the oil industry.

Needy Boys Guests of Oil Men at Pyles Camp

California oil men and women, sponsors of the Pyles Boys Camp, were hosts to 237 boys from 42 communities in five oil producing counties of the state during the past summer. The camp, founded by veteran oil man, R. M. "Uncle Bob" Pyles, general superintendent of Southwest Exploration Company at Huntington Beach, is in the Sierra National Forest along the Kern River some 30 miles from Springville, California.

Prominent oil men visiting the camp during the summer included P. S. Magruder, executive vice president of General Petroleum, and R. H. Green, vice president of Signal Oil & Gas Company, both of Los Angeles. Magruder and Green serve on the child procurement committee, which is charged with the all important task of determining the qualifications required for a youngster to attend the camp. They are also members of the twenty-man board of directors, composed for the most part of well-known West Coast oil executives.

NPC Asked to Study Necessity of PAD

Acting Deputy Administrator of Petroleum Administration for Defense, H. A. Stewart, has asked the National Petroleum Council to make a study to determine the need for PAD after June 30, 1954. Stewart said unless a further crisis develops, it appears that PAD will not be needed after this time, and that the oil and gas division, a normal peacetime organization, could take care of developments.

Major difference in the PAD and oil and gas division is that the PAD was largely staffed with men from the oil and gas industries, and the oil and gas division was made up of career federal government workers.

OIIC Shows Movies to 7,000,000 First Half 1953

The Oil Industry Information Committee's theatrical distribution program has enabled close to 7,000,000 persons to see two of its motion pictures during the first six months of 1953, executive director H. B. Miller reported.

The theatrical distribution program was started last January. The two motion pictures involved are "24 Hours of Progress," and "Man on the Land," both of which won citations from Freedom Foundation, Inc., for their excellence in portraying the American way of life.

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FOR SALE: 1 Wilson Mogul Drilling Unit with 3 WAK Waukesha motors, 2 completely rebuilt and not used since, and 1 in perfect condition. One 122-ft. Parkersburg derrick with 24-ft. floor base, 350,000 lbs. capacity with 8-ft. slip structure, crown block swivel, 2 houses, and other accessories. Write Box 153 % The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

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Excellent opportunity for man with experience in secondary oil recovery by water flooding and who has formal training in microbiology to do sales and service work with firm well established in field of industrial micro-organism control. Training period, salary plus commission. All replies confidential. Write fully Box 152 % The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

Departmental Changes at Sunray Are Announced

Sunray Oil Corporation's former manufacturing, sales and pipe line department will hereafter be known as the refining and pipe line department and R. L. (Dick) Johnson, Duncan, Oklahoma, former manager of the company's refining division will be manager of the department with offices in Tulsa. R. W. Griffith, Tulsa, who has been administrative assistant in the department, has been simultaneously named assistant manager of the department. H. W. Manley has resigned his Sunray position.

Johnson joined Sunray in 1928 when the company acquired the Homaokia Oil Company refinery at Allen, Oklahoma. He was superintendent of that plant for Sunray from 1928 to 1946, and was manager of Sunray's catalytic cracking refinery at Duncan until his present new assignment.

Griffith joined the company in 1948. He formerly was manager of gas-gasoline operations. J. R. (Dick) Ellis, Tulsa, has been named manager of product pipe lines and special pipe line projects in which Sunray is interested. G. W. Martin, Victoria, Texas, is South Texas district superintendent, and Joe Kanive, Allen, Oklahoma, is Oklahoma district superintendent for the crude oil pipe line division within the new refining and pipe line department.

R. C. Underwood, superintendent, and C. H. Barnes, assistant superintendent, remain in these capacities at the Duncan refinery. T. L. Tiernan, superintendent, and A. A. Milne, assistant superintendent, remain in these capacities at the company's Allen, Oklahoma, refinery. F. W. Borden, Los Angeles, California, manager of Sunray's West Coast operations, has also been named manager of Sunray's Santa Maria, California, refinery and R. L. Harsin is superintendent of this refinery.

P. M. Broach, Tulsa, is manager of Sunray's crude oil purchase and sales. W. H. Carruth is office manager in the refining and pipe line department. The technical services division, formerly attached to the department, will be established as a separate service department for all divisions of the company's operations and will continue to be headed by L. G. Rodgers, Tulsa, department manager.

Rinehart Opens New Office

Rinehart Oil Report has opened a new editorial office at Billings, Montana, in the Benete Building at 219½ North Broadway.

Vann Mitchell, formerly in Rinehart's Midland and Dallas, Texas, offices, has been transferred to Billings. James R. Quinn of Denver is manager of the Rocky Mountain district with Dick Sebald representing the company at Casper and Jack Pierce in charge of the Bismarck office.

U. S. Oil Imports Take Slight Dip

Oil imports into the United States went below the 1,000,000 bbl per day average during the week ended September 12, according to the American Petroleum Institute. Daily average was 945,900 bbl, compared with 1,021,000 the week before. Decline was due to lower imports into California the week of September 12.

Week ended	Crude oil	Residual fuel oil	Distillate fuel oil, asphalt, etc.	U. S. total
August 15.....	632,900	246,600	29,100	908,600
August 22.....	577,200	206,800	29,100	826,700
August 29.....	788,700	229,700	43,600	1,062,000
September 5.....	768,500	240,400	12,100	1,021,000

Humble Gives Fellowships

Twenty fellowships totaling $40,800 have been given by Humble Oil and Refining Company to be used at colleges and universities during the 1953-54 school year.

The fellowships will enable selected students to do graduate work in geology; chemistry; accounting; physics; law; and petroleum, chemical, civil, and mechanical engineering.

Schools receiving fellowship grants were Rice Institute, University of Texas, Texas A. & M., University of Oklahoma, Louisiana State, Georgia Tech., UCLA, Alabama Polytechnic Institute, and MIT.

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Nabeth, Pa.—J. W. Worthington, 105 Forrest Ave.
Newark, N. J.—Murray Eskin, Industrial Office Bldg.
New York—Henry Stein, 50 Cliff St.
Portland, Ore.—Earl H. Jones & Co., 1233 NW 12th Ave.
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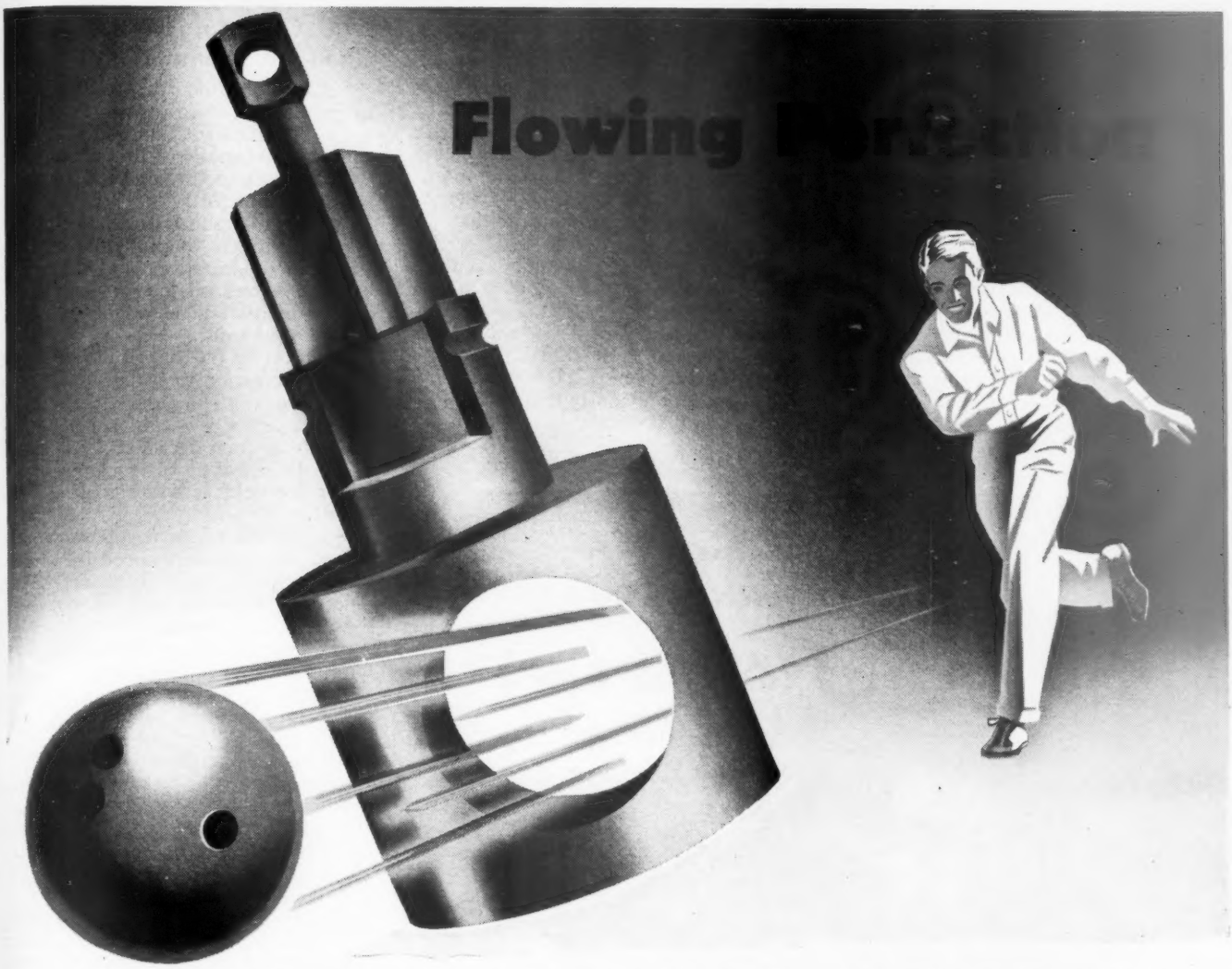
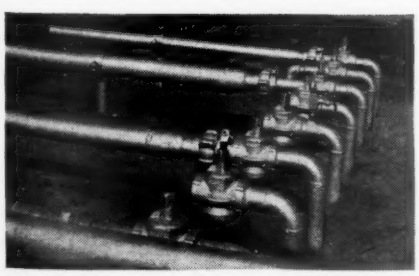
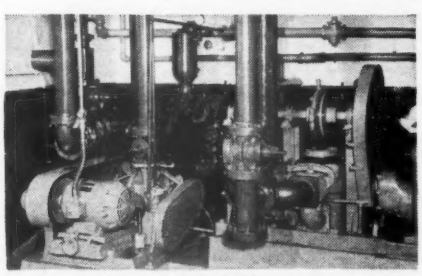


Straight through, clean as a whistle! That's the kind of *flow perfection* you get with an a.c.f. Round Port Valve. Because they're the exact same size and shape as the pipe itself, there are no obstructions. You *always* get full capacity flow of heavy viscous ladings... without loss in head pressure. There are no abrasive effects from solids in suspension.

The full pipe area and non-wedging effects of Round Port Valves are also found in a.c.f. Rectangular Port Valves. Both are designed to give you long, trouble-free service with minimum maintenance. Don't settle for less than the very best. It pays!



The Petroleum Industry finds full-pipe area of a.c.f. Valves of great advantage on both natural gas and crude oil.



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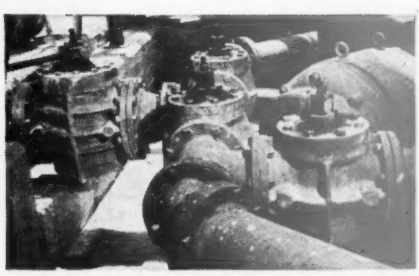

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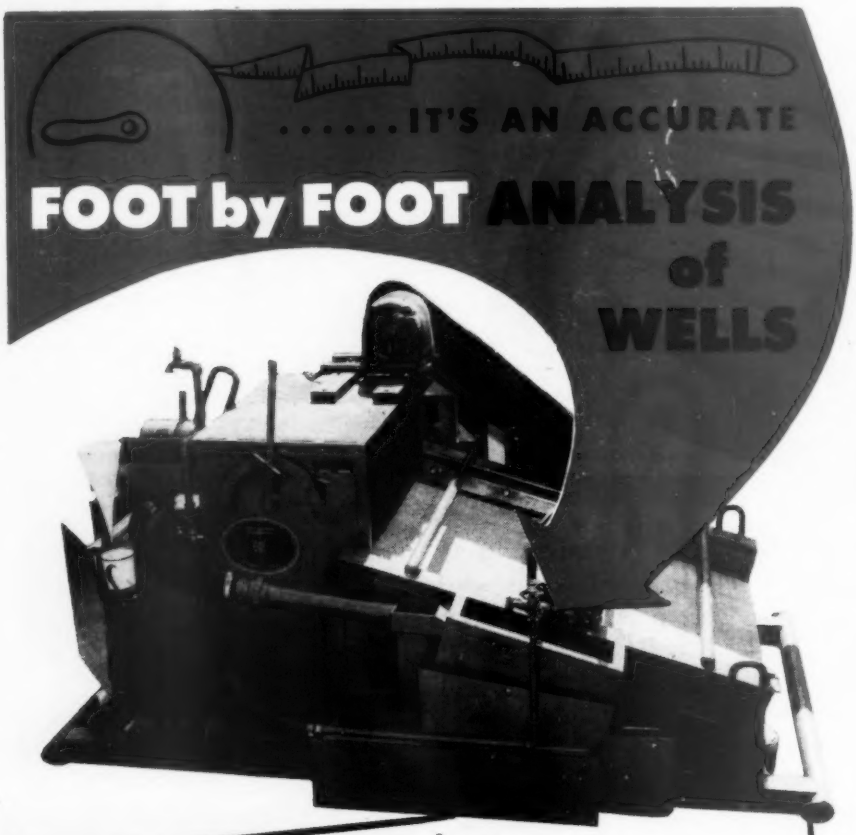
PAD Says Drilling Goals Have Been Reached

The Petroleum Administration for Defense announced recently that there is plenty of crude capacity to meet initial impact of wartime requirements, but still not enough refining facilities. A PAD spokesman went on to say that the industry will be able to drill enough to keep up with growing demands and maintain reserves at the beginning of this year.

Many independent producers, through Russell Brown, IPAA's general counsel, did not agree with the PAD announcement. Brown said there is no real "reserve producing capacity in the U. S. above current demand. There is only a shut-in capacity which is the result of imported oil." Brown pointed out that the PAD report was based on the continuing availability of foreign oil.

In the meantime many small refiners are complaining that they cannot maintain refineries at wartime capacities without actual war demands to take up the surplus.

Some time ago PAD announced refining capacity goal of 8,500,000 bbl daily by January 1, 1955, and new "tentative" goals for 1956 and 57 of 8,750,000 and 9,000,000 bbl respectively. This is drop of 300,000 bbl daily for 1955, as previously announced capacity was 8,800,000.



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OIIC Operating Structure Changed; Promotions Given

A change in the operating structure of the district offices of the Oil Industry Information Committee, and a series of promotions to effectuate it were announced by H. B. Miller, executive director.

New plan resulted from a study of ways and means to strengthen the entire field organization, and to enable more volunteer oil men to participate in the industry-wide public relations program, he said.

Revision in the operating structure calls for creation of three new supervisory positions in the field. These regional supervisors will supervise all activities in their areas, and will work under the direction of the Deputy Director for field activities in the main office.

Two of the regional supervisor appointments were announced by Miller. They are M. J. Rupp, of Denver, Colorado, senior district representative in the Rocky Mountain district office, and E. E. Robinson, of Philadelphia, senior district representative in the Middle Atlantic district office.

Other promotions and changes announced by Miller include:

Joseph W. Palmer, of Denver, promoted to be senior district representative in the Rocky Mountain area, succeeding Rupp; Burton B. Thompson, a new man, to be second district representative in Denver, taking over Palmer's old spot;

David H. McIlvaine, of Philadelphia, promoted to be senior district representative in the Middle Atlantic district, succeeding Robinson; and Bates D. McClean of Philadelphia to the other place in that district office.

Appointment of A. Dunson Dunaway, of Atlanta, Georgia, to succeed Louis M. Connor, Jr., a district representative who resigned.

Promotion of Ben Ames, heretofore assistant field supervisor in the New York headquarters, to manager of educational activities in the main office.

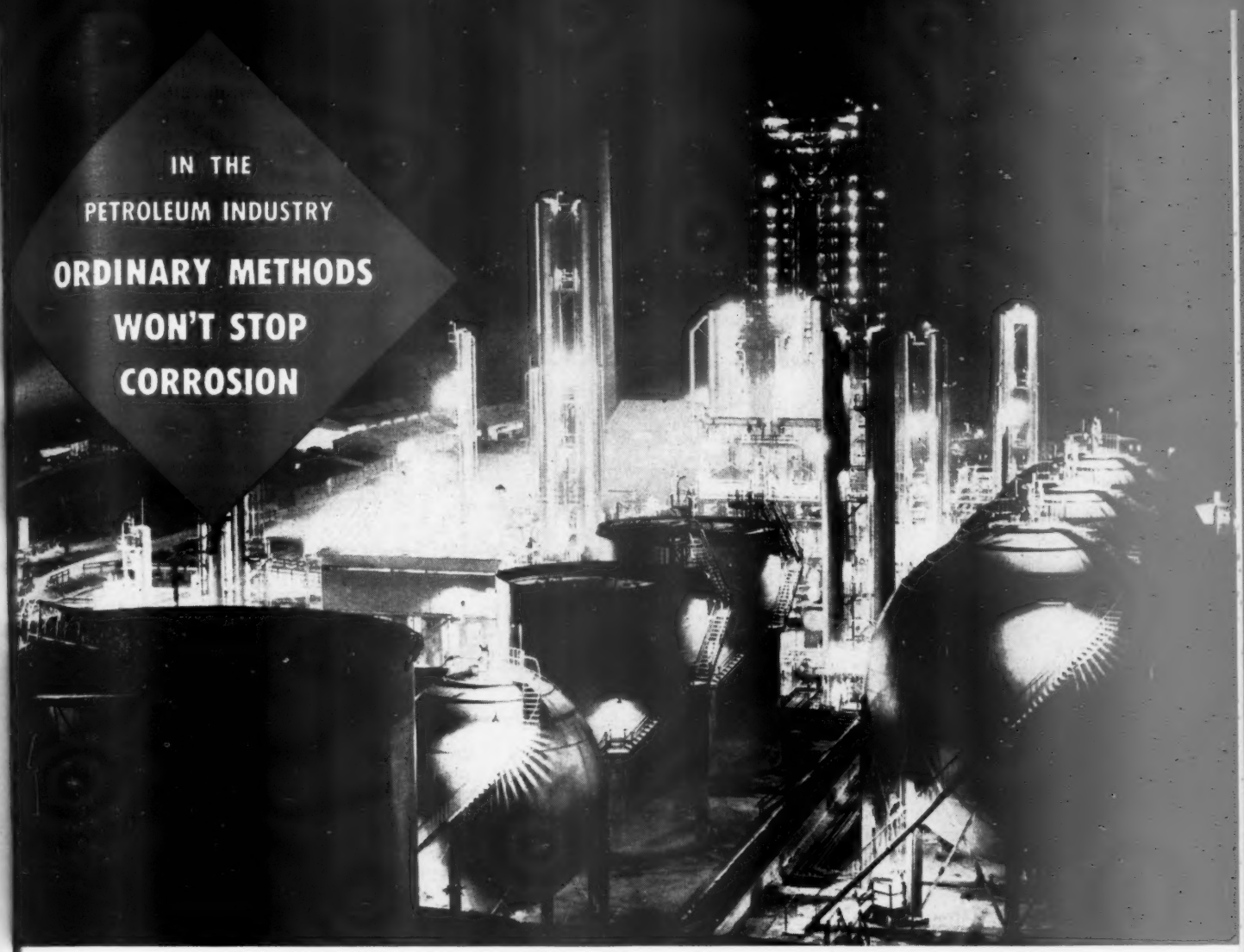
PAD to Revoke Order No. 4

Because the aviation-gasoline supply situation has improved markedly, the Petroleum Administration for Defense has revoked PAD Order No. 4, Deputy Petroleum Administrator Joseph A. LaFortune announced.

This order requires the use of at least 4 cc of tetraethyl lead (TEL) in each gallon of the higher grades of commercial aviation gasoline for domestic use; 4.6 cc in each gallon for export.

Issued October 19, 1951, the order insured that tetraethyl lead, rather than scarce alkylate, would be used to raise the octane rating of commercial aviation gasoline. As a result more alkylate was available to boost production of military avgas.

Revocation of Order 4, LaFortune emphasized, does not mean that aviation gasoline is in abundant supply but that it is adequate for current needs.



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4. Complete stocks of fresh materials always near you at one of AMERCOAT's five regional warehouses or more than 20 franchised distributor warehouses throughout the United States.

5. Service based on experience. The AMERCOAT method of corrosion control is the result of nearly 20 years' experience in solving or controlling corrosion problems in every major industry throughout the United States.

Write today for the name and address of the AMERCOAT representative in your area. At no obligation, he will gladly help you analyze your corrosion problems and evaluate your present control measures. If it is determined that you have a problem within our scope of experience, he will outline a complete program of AMERCOAT's PLUS protection for your plant or equipment.

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PERSONALS

▸ **Marshall Newcomb,** general counsel for the Lone Star Gas Company, was elected chairman of the mineral law section of the American Bar Association at its annual convention in Boston, Massachusetts, recently. The section, comprising between 400 and 500 members, specializes in oil and gas law and hard minerals law. Newcomb has served as chairman of the bar association's natural gas committee and is a past member of its council which is comparable to a board of directors.

Newcomb, a native of Austin, was named general attorney for Lone Star in March, 1944, at the age of 39, becoming one of the youngest general attorneys of any large corporation in the state.

▸ **R. P. Brooks, Jr.,** has been elected vice president and director of Rinehart Oil News Company of Dallas. Brooks, former oil editor of the Dallas Times Herald and Shreveport Journal, joined the Rinehart organization nearly two years ago. He has been handling special projects and editorial supervision.

H. H. West

C. Z. Hardwick

E. B. Redpath

▸ **H. H. West,** secretary, has been elected to the board of directors to fill the vacancy caused by **E. B. Redpath,** who has retired as director and executive vice president of The Ohio Oil Company. West continues in his capacity as secretary.

C. Z. Hardwick, formerly vice president and manager of refining and marketing, has been elected executive vice president succeeding Redpath. Hardwick became a director of the company in 1948.

A formal tribute to Redpath was made by the board of directors.

Redpath was elected secretary of the company in 1928, a position to which he devoted nearly half of his 48 years of service. He has served as a director since 1932, and was elected executive vice president in 1951.

West began his career with Ohio Oil in 1922. In 1948 he was given the additional duty of assistant secretary, and served in both capacities until his election as secretary in 1951.

Hardwick joined Ohio Oil in 1921. He was appointed manager of the refining and marketing department, and vice president of the company in 1945.

▸ **T. C. Morrison,** director, vice president, assistant treasurer, and comptroller of Forest Oil Corporation has retired, concluding nearly 30 years of service in the firm's home office in Bradford, Pennsylvania. During this period he witnessed and participated in the initial large scale application of waterflooding techniques, which were first developed in the Bradford field and which have since found general acceptance in the field of secondary recovery.

Justin Kimball who, for the last 8 years, has been connected in a similar capacity with H. R. Cullen of Houston, Texas, succeeds Morrison. Kimball is well known in Southwest financial circles and is prominent in the field of public accounting and federal taxation. He recently moved from Houston to Bradford where he will maintain his residence.

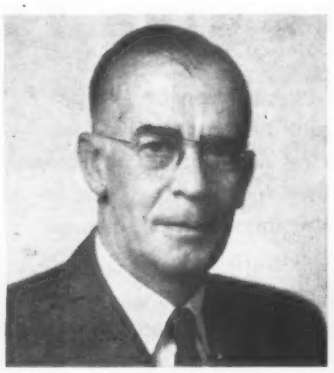
▸ **Dr. D. M. Morrison** has been named vice president — manufacturing and **R. P. Ritchie** as vice president—transportation and supplies of Shell Oil Company of Canada, Ltd. Both Morrison and Ritchie will continue to have their headquarters at the company's head office in Toronto and direct Shell's Canadian operations in their respective fields.

Dr. Morrison has a record of more than 25 years' service with Shell, during which time he held important posts in the firm's manufacturing department. He attended the University of British Columbia, McGill University, and obtained his PhD from Cambridge.

Ritchie joined Shell in 1934 and since that time has had varied experience in different phases of the company's operations. He was graduated from University of Toronto in 1933.

J. H. Thacher

E. G. Gaylord



H. C. King

F. S. Slick

▸ **John H. Thacher** has been named vice president of California Research Corporation. A petroleum engineer and geologist, Thacher has been with Standard since 1930. For the last three years he has held the title, executive assistant to the vice president, specializing in problems connected with the Naval Petroleum Reserve at Elk Hills.

At California Research Corporation Thacher will take over direction of the oil field research program now headed by **E. G. Gaylord,** who retired.

Gaylord, who has served as a vice president and director of California Research since 1947, is a petroleum engineer whose California oil field experience dates back to 1911. He joined Standard in 1926 as chief petroleum engineer with acquisition of Pacific Oil.

▸ **H. C. King,** former controller of The Ohio Oil Company, has been elected to the newly established office of financial vice president.

F. S. Slick, assistant controller, has been appointed controller.

King was first employed by The Ohio Oil Company as a clerk in the production department at Findlay in 1921. In 1941 he was appointed controller with supervision of all accounting and auditing for the company and its subsidiaries, and was elected to the board of directors in 1946.

A graduate of Ohio Wesleyan University, Slick began his permanent employment with Ohio Oil as a production accounting clerk at Findlay in 1926. He was appointed assistant controller in 1941.

NEW OFFICERS Houston Desk and Derrick Club were installed recently. They are: Bernice Collis, Jack W. Frazier, president; Audrey Stoker, Houston Slush Pump Repair, first vice president; Leah Vinson, Gulf Oil, second vice president; Ida Brigham, Humble Oil, corresponding secretary; Tillie Odom, Ginther, Warren and Ginther, recording secretary, and Ruth Hunter, Houston Production, treasurer.

Harry F. Glair, director of purchases and long-time manufacturing executive of Standard Oil Company (Indiana), retired from active duty on August 27, 1953. A director of the company since 1934, he joined Standard as a clerk in the machine shop at its Whiting, Indiana, refinery 47 years ago.

Richard J. Dent and **James T. Rasbury,** well known in legal and industrial relations fields in the petroleum industry in the Southwest, has established a new law firm in Tulsa, Oklahoma. They will engage in the general practice of law, specializing in labor relations law, oil and gas law, and anti-trust law. Offices of Rasbury and Dent will be located in the Oil Capital Building, 507 South Main Street, Tulsa.

Rasbury, a native of Texas and a former agent for the Federal Bureau of Investigation, received his undergraduate degree at Michigan State Normal College and studied law at the University of Oklahoma before receiving his law degree from The George Washington University in Washington, D. C. Dent, a native Kansan, also is a law graduate of The George Washington University.

Daniel V. Terrell has been elected president of The American Society of Civil Engineers. He is Dean of the College of Engineering, University of Kentucky. Dean Terrell, who will succeed Walter L. Huber, of San Francisco, will be installed October 21 at the Society's annual meeting, to be held in the Statler Hotel, New York. He will serve one year.

Two vice presidents and six directors also have been elected in a mail ballot of the more than 36,000 members. They will be inducted into office at the October convention. Vice presidents are elected for two years and directors for three.

The new vice presidents will be **Enoch R. Needles** for Zone I and **Mason G. Lockwood** for Zone 4. Needles is a member of the firm of Howard, Needles, Tammen and Bergendoff, New York. Lockwood is a member of the Houston Texas, firm of Lockwood and Andrews.

R. D. Rogers has been appointed a vice president of Tide Water Associated Oil Company, and vice chairman of the operating committee, Eastern division. Rogers, recently appointed manager of the transportation and supply department, Eastern division, with headquarters in New York City, has been in the service of Tide Water Associated and its predecessor companies for more than 30 years.

R. L. Tollett was recently elected president of Cosden Petroleum Corporation at a meeting of the stockholders; **Nelson Phillips, Jr.,** was named vice president, general counsel and assistant secretary; **Marvin M. Miller, Douglas L. Orme** and **R. W. Thompson,** vice presidents; **A. V. Karcher,** secretary and treasurer; **V. A. Whittington** and **L. T. King,** assistant secretaries and assistant treasurers; and **Alma C. Gollnick,** named assistant secretary.

Newly elected directors reviewed operations of the company over the past year and approved plans of the management for the coming year.

Perry A. Gill, Midland, Texas, has been named purchasing agent for Sunray Oil Corporation, it was announced by W. C. Whaley, Sunray's president.

Gill was formerly North and West Texas district production superintendent for Sunray.

He joined the Sunray organization in March 1946 as district engineer for the company's North and West Texas operations and in March of 1948 was named superintendent of Sunray's widespread producing operation in the area. He had formerly been associated in field engineering and production capacity with another producing company and has had wide experience in oil field purchasing under Sunray's former decentralized system of purchasing.

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OUTSIDE AND INSIDE

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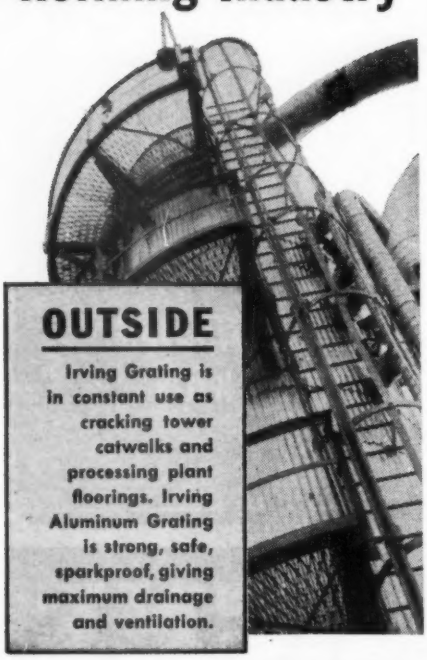

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Irving Grating is in constant use as cracking tower catwalks and processing plant floorings. Irving Aluminum Grating is strong, safe, sparkproof, giving maximum drainage and ventilation.

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Irving Ganister Lining Retainer Grid retains castable refractory lining materials, thus assuring a practically non-collapsible and non-breakable lining in cracking towers.

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DEATHS

Robert A. Smith, manager of The Continental Supply Company's price book division, died September 12 at his home in Dallas, Texas, after suffering a heart attack. Smith joined Continental in St. Louis, Missouri, 33 years ago, and moved with the company to Dallas in 1933.

R. E. Shackelford, Tulsa, general manager of the Perrault Equipment Company, died in a Tulsa hospital August 25. He had suffered a paralytic stroke Monday night.

Affiliated with the pipe line business all of his adult life, Shackelford went to Tulsa from Skiatook in 1930. He had served with the Perrault Equipment Company for 8 years.

Thomas Watson Bell, retired steel executive, widely known also in the California oil industry, died on September 4, following an extended illness. Bell, a native of Coatbridge, Lanarkshire, Scotland, was formerly sales manager in the Los Angeles area for Jones and Laughlin Steel Company.

Clarance A. Pollard, since October 1, 1951, general manager of Standard Oil Company of California's refinery at El Segundo, California, died August 27 from a heart attack. He had been with Standard for 32 years, coming to El Segundo from Richmond.

Harry L. Ericson, of Amarillo, Texas, passed away suddenly on August 4. Ericson was chief chemist for the Continental Carbon Company in Amarillo. Prior to his transfer to Continental in 1951, Ericson worked in the carbon black division of Witco Chemical Company for three years, both in New York and Chicago.

George S. Hinkle, oil man from Houston, Texas, died of a heart attack last month in Houston. Hinkle was principal owner of the Hinkle Drilling Company, a director of the General Manufacturing Company, and had extensive oil and ranch properties. He began as an oil field hand and lived to make major oil discoveries.

J. S. Shearer died August 25. In 1940, Shearer was elected assistant treasurer of the Southwestern Development Company, becoming treasurer in 1945, which position he held until his death.

Ralph B. Lloyd, one of California's most noted pioneers and president of Lloyd Corporation, died on September 9. He was the virtual discoverer of Ventura Avenue field in Ventura, which has been a prolific multi-zone producer. At the time of his death, Lloyd was a director of the American Petroleum Institute, Western Oil & Gas Association, and the Oil Producers' Agency. He was a a past president of the Producers' group, was seven times president of WOGA, and from 1941 to 1945 was a member of the Petroleum Industry War Council.

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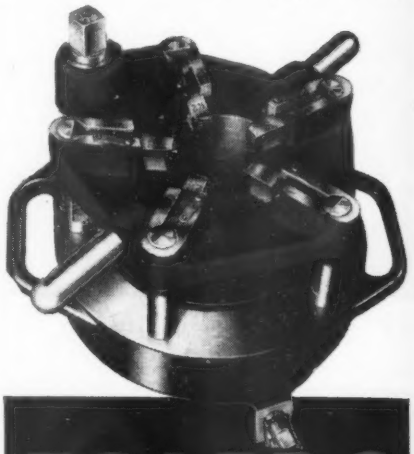

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WIRE LINES FOR ROTARY DRILLING
TON-MILE RECORDS, AND CUTTING OFF PRACTICES

Since rotary drilling rigs were first put in operation, attempts have been made to set up an accurate method for evaluating the service received from rotary lines. Feet of hole drilled, which provides a reasonably accurate gage of cable tool line service, obviously cannot be applied to rotary drilling lines. In an effort to provide a more accurate determination the ton-mile method was developed. This method has undergone several revisions, being occasioned by the desire to include more of the variables entering into rotary line operation, thereby making the ton-mile record as representative as possible of actual service.

The ton-mile record provides a reasonably satisfactory means of evaluating rotary line service, but does not provide for a number of variables in operation of the line that may cause wide variations in service records.

The most accurate formula developed to date is that shown in the API Standards. This formula includes as many as possible of the variables encountered in the hoisting and drilling operations.

The ton-mile method of determining rotary line service takes into account the following:

1. Ton miles making round trips with pipe.
2. Ton miles running casing.
3. Ton miles due to traveling block assembly.
4. Ton miles due to drill collars.
5. Ton miles coring.
6. Ton miles drilling.
7. Allowance for buoyancy of mud.

The ton-mile method does not take into account the following:

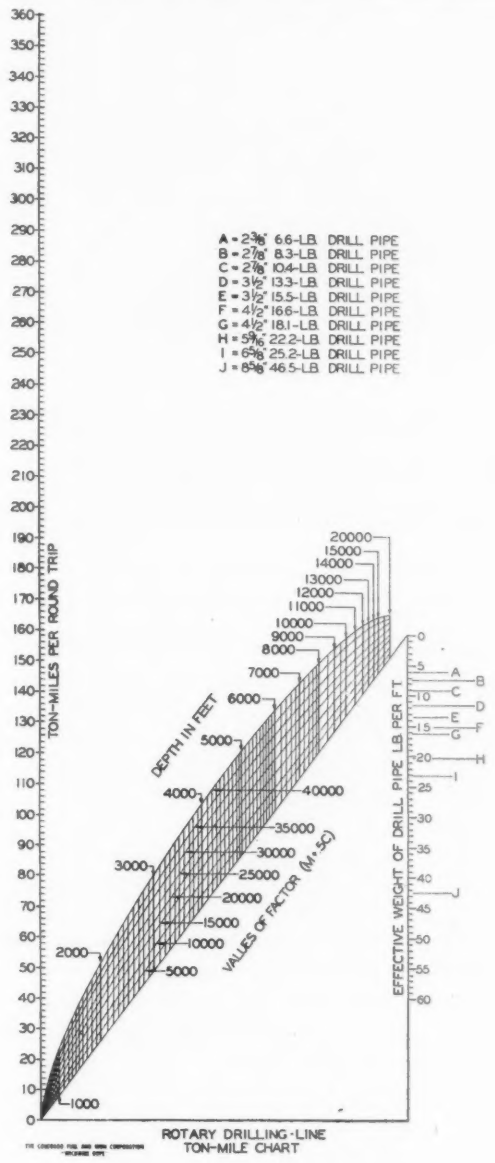
1. Safety factor under which the line operates.
2. Diameter of drums and sheaves in relation to rope diameter.
3. Condition of sheave grooves.
4. Excessive loading that may be encountered due to stuck drill pipe, etc.
5. Line speed, which varies with different rigs and different numbers of lines strung in derrick.
6. Practice followed in cutting off and moving line to distribute wear and bending fatigue.
7. Type and grade of line.
8. The proportionately greater bending caused by running of light strings to deep depths, such as running 2-in. tubing, which results in excess line travel in comparison to ton-miles.

The API ton-mile method is the best available method for evaluating lines, and is particularly useful in comparing lines used on similar rigs, operating at similar depths. In comparing ton-mile records thus obtained full consideration of all the variables listed above should enter into the comparison, and should form a part of the complete record on the lines.

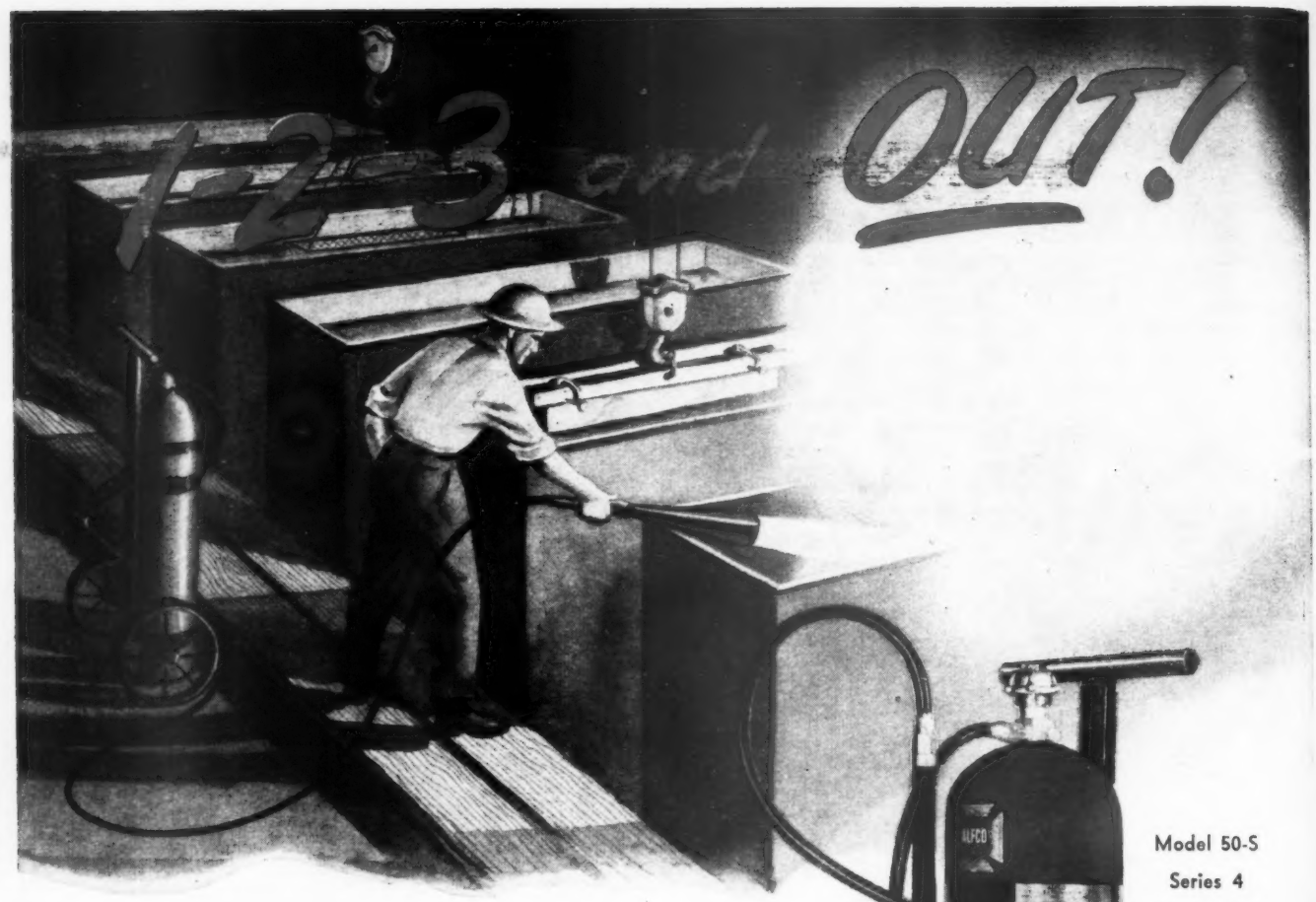
Some of the variables may be eliminated by the operator himself by maintaining an adequate safety factor, regular inspection and re-grooving of sheaves, and by following a uniform procedure for cutting off and moving the line on the drum.

API Ton-Mile Chart

The scale used in reproducing the ton-mile chart appearing in the API Standards is so small as to make use of the chart very difficult. This chart has been photographically enlarged, and traced, in order to provide clean lines and insure legibility, greatly facilitating the use of the chart and providing more accurate determinations.


A = 2 3/8" 6.6-LB DRILL PIPE
B = 2 7/8" 8.3-LB DRILL PIPE
C = 2 7/8" 10.4-LB DRILL PIPE
D = 3 1/2" 13.3-LB DRILL PIPE
E = 3 1/2" 15.5-LB DRILL PIPE
F = 4 1/2" 16.6-LB DRILL PIPE
G = 4 1/2" 18.1-LB DRILL PIPE
H = 5 9/16" 22.2-LB DRILL PIPE
I = 6 5/8" 25.2-LB DRILL PIPE
J = 8 5/8" 46.5-LB DRILL PIPE
TON-MILES PER ROUND TRIP
DEPTH IN FEET
VALUES OF FACTOR (M+SC)
EFFECTIVE WEIGHT OF DRILL PIPE LB PER FT
ROTARY DRILLING-LINE TON-MILE CHART

Courtesy Wickwire Rope, The Colorado Fuel and Iron Corporation.



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Lighter in weight, faster in operation, more easily serviced than the heavier model it succeeds, the Series 4, Model 50-S Alfco Carbon Dioxide Wheeled Engine is a one-man fire killer of Class B and C blazes too big for hand portable extinguishers.

It is a trim, streamlined engine, stronger in construction with excellent balance in wheeling position. With a shorter cylinder, but slightly larger in circumference, the center of gravity is lowered and the ease of maneuverability for one-man operation is greatly increased. With a minimum of bulk, it has everything needed for fast and efficient fire-fighting.

The Model 50-S may be operated in an upright or lowered position. The cylinder valve may be opened before or after the hose has been uncoiled at the scene of the fire, but the squeeze lever-type valve on the horn should not be operated until ready to extinguish the fire.

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ALFCO

For most convenient use, it is recommended that this chart be cemented on fiberboard, such as masonite.

The value of factor (M + .5C) as shown on the chart is derived as follows:

M = Total weight (in pounds) of block, hook, links, and elevator.

C = Excess drill collar weight (with allowance for buoyancy).

$= (L \times C_m) - (L \times W_m)$.

L = Length of drill collar assembly in feet.

C_m = Weight per foot of drill collar in mud.

$= C_a (1 - .002B)$ lb.

W_m = Weight per foot of pipe in mud.

$= W_a (1 - .002B)$ lb.

In which formulae

C_a = Weight per foot of drill collar in air in pounds.

W_a = Weight per foot of drill pipe in air in pounds.

B = Weight of rotary mud in pounds per cubic foot.

It is suggested that the values of C be established for the various standard sizes of drill pipe used and for the various usual combinations of drill collars, so that ton-mile determinations may be readily made, using the proper predetermined value of C in the factor M + .5C for the size of drill pipe, and the length and size of drill collars involved.

The following table provides the values of C and .5C for 4½-in., 16.6-lb drill pipe and various lengths of 6-in. drill collars, which is probably the combination used most generally.

Weight in air of 4½-in. drill pipe without tool joints = 16.6-lb per ft.

Weight of 4½-in. tool joints = 75 lb (approx.)

Weight in air of 6-in. drill collar = 75 lb per ft (approx.)

Weight of mud = 75 lb average (assumed).

4-½ in., 16.6-lb drill pipe with 6-in., 30-ft drill collars.

Number of drill collars	Length of drill collar, feet	Value of C, pounds	Value of .5C, pounds
1	30	1,450	725
2	60	2,900	1,450
3	90	4,350	2,175
4	120	5,800	2,900
5	150	7,250	3,625
6	180	8,700	4,350
7	210	10,100	5,050
8	240	11,550	5,775
9	270	13,000	6,500
10	300	14,450	7,225
11	330	15,900	7,950
12	360	17,350	8,675
13	390	18,800	9,400
14	420	20,250	10,125
15	450	21,700	10,850
16	480	23,150	11,575
17	510	24,600	12,300
18	540	26,000	13,000
19	570	27,500	13,750
20	600	28,950	14,475

Courtesy Wickwire Rope, The Colorado Fuel and Iron Corporation.

For example, with a weight of traveling block assembly of 20,000 lb, and using 14 6-in. drill collars, the value of the factor M + .5C as shown on the chart would be 20,000 lb + 10,125 lb = 30,125 lb. The curve on the chart for M + .5C = 30,000 lb would be used in figuring the ton-miles.

Use of Ton-Mile Chart

Although a straightedge may be used for reading the chart, we recommend the use of a fine cord or thread with one end formed into a loop around a pin, if the chart is mounted on a rigid backing such as masonite.

1. Insert pin held in the looped end of the cord at the proper point in the vertical scale "Effective Weight of Drill Pipe Pounds per Foot" corresponding to the size of drill pipe used.

2. Holding the cord taut by the other end, swing it around the pin as a center and place it so that it crosses the proper intersection of the vertical line "Depth in Feet" and the curved line "Values of Factor (M + .5C)" corresponding to the depth at which the trip is made and the value of (M + .5C) previously determined.

3. Read from the vertical scale "Ton-miles per Round Trip" the ton-mile value where the cord intersects the scale.

Ton miles setting casing = ½ × ton-miles for a round trip for corresponding weight of drill pipe. The value of (M + .5C) becomes only the weight of the traveling block assembly, since no drill collars are involved.

Ton-miles drilling = 3 × (ton-miles one round trip at finish less ton-miles one round trip at beginning).

To record ton-mile service most conveniently, use a "Rotary Drilling Line History" chart, several samples of which may be found in the pocket on the inside back cover of this handbook.

Wickwire Ton-Mile Tables

Wickwire Ton-Mile Tables, are based on the API ton-mile formula. These tables provide a new and simple method of arriving at the total ton-mile service, and a wide range of drill pipe weights and excess weights is included. These tables should prove especially helpful when used in the field at the rig, as the only computation necessary is the evaluation of the excess weight, which remains constant during long periods of operation. When the excess weight is established, the ton-mile total for each round trip may be easily located in the proper table.

A simple formula for excess weight follows. It is assumed that mud is used weighing approximately 10 lb per gallon, or 75 lb per cubic foot.

Excess weight = $M + .425L (C_a - W_a)$.

Where M = Total weight (in pounds) of block, hook, links, and elevator.

L = Length of drill collar assembly (ft).

C_a = Weight per foot of drill collar in air.

The Lady was for burning

In rural Indo-China, a farmer once offered a traveler his prettiest daughter in exchange for a reading lamp and a drum of kerosene.

This happened, not fifty years ago, but within the last decade.

It is hard for Americans to imagine what life is like in the "have-not" nations of the world. Some communities in Honduras have never seen petroleum, nor any product thereof. In Western Africa it is not unusual to find one lamp in a tribal group of 15,000 people.

The fact that a country has no petroleum resources of its own is not always the reason for oil poverty. Many so-called "have-nots" live in land where oil could be found. What they really "have not" is the initiative to look for it!

The oil companies of America have a super-abundance of that great natural resource—Initiative. It is essential to their success. They cannot afford to discourage easily, for the odds are ten to one against a wildcat becoming a producer.

In spite of these odds, Cities Service has discovered some of America's historic oil fields. In the last five years, its geologists have added millions of barrels of much-needed oil to our national reserves. Because of these men, and others like them throughout the industry, we can be sure our country will never be one of the petroleum have-nots of the world.

CITIES SERVICE

Quality Petroleum Products

Typical Drill Collars

O.D. (in.)	I.D. (in.)	C_a (lb)
3¾	1¼	33
4¼	1½	42
5½	2¼	67
5¾	2¼	75
5¾	2⅞	66
6	2¼	83
6	2¾	75
6¼	2¼	91
6¾	2¼	108
6¾	2¾	100
7	3	107

W_a = Weight per foot of drill pipe in air. Allowing for tool joint, the values to be used for standard drill pipe are as follows:

Drill pipe	W_a (lbs.)
2⅞", 10.4 lbs.	10.95
3½", 13.3 lbs.	13.97
4", 14.0 lbs.	15.59
4", 15.7 lbs.	17.35
4½", 16.6 lbs.	17.64
4½", 18.1 lbs.	19.10
4½", 20.0 lbs.	21.35
5", 19.5 lbs.	20.85
5½", 24.7 lbs.	26.60

The method of arriving at ton-miles per round trip when setting casing, and ton-miles due to drilling is detailed in the "Use of Ton-Mile Chart" section, (Sheet 2). When running tubing, or drilling with sizes and/or weights of drill pipe other than those included in the tables, the ton-mile chart must be used.

Loads and Safety Factors

When a wire rope is reeved over a number of sheaves in a block and tackle system, the load on the line is greater than the total load divided by the number of parts of line, due to the loss caused by friction in the sheaves, and bending of the rope around the sheaves. The efficiency factor of various parts of line for roller bearing sheaves has been established as follows:

6 Parts of line efficiency factor = .874.

8 Parts of line efficiency factor = .841.

10 Parts of line efficiency factor = .810.

The maximum load on the fast line may be determined from the following formula:

$$P = \frac{W}{N \times E}$$

Where

P = load on fast line in pounds.

W = hook load including traveling block assembly in pounds.

N = number of parts of line.

E = efficiency factor.

Using the above formula, the fast line load, hook load, and dead-line load for various safety factors have been computed, and appear in the tables (Sheets 4, 5, and 6), covering the six types of lines regularly used by most operators.

The following values for weight of traveling block assembly are assumed:

1-in. diameter line — 15,000 lb.

1⅛-in. diameter line — 20,000 lb.

1¼-in. diameter line — 25,000 lb.

To determine the safety factor including the weight of drill collars:

1. Compute the length of drill pipe equivalent to the weight of the drill collars.

2. Add result of step (1) to the total depth.

3. Subtract from the result of step (2), the total length of the drill collars.

The value for effective depth thus obtained should be used in determining the safety factor.

Example:

To determine the safety factor using a 1⅛-in. IWRC line at a depth of 8,000 ft with 10-30 ft drill collars weighing 75 lb per ft and 8 lines in the derrick.

1. Weight of 10-30-ft drill collars = 10 × 30 × 75 = 22,500 lb.

The equivalent in length of 4½-in. drill pipe = 22,500 ÷ 16.6 = 1,355 ft.

2. 8,000 ft + 1,355 ft = 9,355 ft.

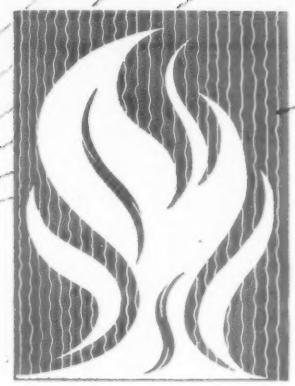
3. 9,355 ft — 300 ft = 9,055 ft.

From the proper graph, the factor of safety at a depth of 9,055 ft using 1⅛-in. IWRC and 8 lines = 4.8.

Courtesy Wickwire Rope, The Colorado Fuel and Iron Corporation.

...dollar per dollar

b.t.u. per b.t.u.....



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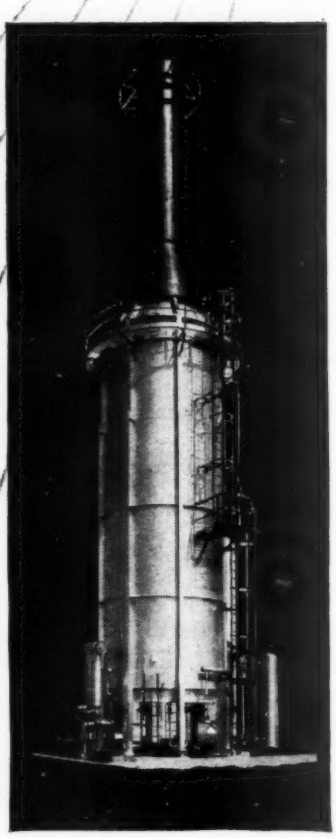
EXCESS DRAFT FOR HIGH OVERLOAD
PLENUM CHAMBERS FOR HAZARDOUS AREAS

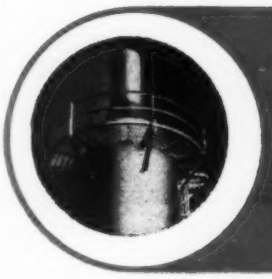


simplicity of design and construction

The Isoflow Heater basically is a circular steel shell; this results in an explosion-resistant structure. The shell is lined on the inside with insulation and insulating refractories; this results in a wall with a zero air leakage and high efficiency. The vertical tubes are combined with integral convection tubes; this results in less headers in the heaters for complete cleanability. The integral radiant convection tubes and minimum number of headers result in a minimum pressure drop for a given velocity. The vertical tubes completely shield the walls resulting in low wall maintenance. The small number of headers in combination with the vertical tubes result in ease of cleaning and, if desirable, gang-cleaning of several tubes simultaneously. Individual burners, symmetrically spaced with relationship to the tubes, results in even heat distribution horizontally. The reradiant cone effects even heat distribution vertically. Segregated burners result in ease of firing and inspection of burners. These are some of the design features which place Isoflow Furnaces in a class of their own

—most efficient by any comparison.

More than 1150 are in operation throughout the world in the petroleum, chemical and allied industries . . . for all processes and for any duty, pressure, temperature and efficiency . . . and all Petrochem-Isoflow Furnaces are pre-eminently satisfactory.



PETROCHEM-ISOFLOW FURNACES

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VOLUME OF GAS LOST IN BLOWDOWN OF LINE

(Gas volumes in table are in M. cu. ft. per 1000 ft. of line)

Initial line pressure on shut-in section, lb. per sq. in., ga.	Nominal diameter of line, in.																			
	2	2½	3	3½	4	5	6	8	10	12	14	15	16	17	18	20	22	24
25	0.040	0.057	0.088	0.117	0.151	0.237	0.342	0.606	0.967	1.360	1.634	1.890	2.164	2.446	2.747	3.423	4.175	5.000
50	.080	.113	.175	.234	.302	.474	.685	1.213	1.934	2.722	3.269	3.781	4.330	4.894	5.495	6.849	8.353	10.00
75	.119	.170	.263	.352	.453	.711	1.027	1.819	2.901	4.082	4.903	5.670	6.494	7.340	8.242	10.27	12.53	15.00
100	0.159	0.227	0.350	0.469	0.603	0.948	1.369	2.425	3.868	5.443	6.538	7.561	8.659	9.788	10.99	13.70	16.71	20.01
125	.199	.284	.438	.586	.754	1.185	1.712	3.031	4.835	6.803	8.172	9.451	10.82	12.23	13.74	17.12	20.88	25.01
150	.239	.340	.526	.703	.905	1.422	2.054	3.638	5.803	8.165	9.808	11.34	12.99	14.68	16.49	20.55	25.06	30.01
175	.278	.397	.614	.821	1.056	1.660	2.397	4.246	6.772	9.529	11.45	13.24	15.16	17.14	19.24	23.98	29.25	35.03
200	0.318	0.454	0.701	0.937	1.207	1.896	2.738	4.850	7.735	10.88	13.07	15.12	17.32	19.57	21.98	27.39	33.41	40.01
225	.358	.511	.789	1.055	1.358	2.134	3.081	5.457	8.705	12.25	14.71	17.01	19.49	22.02	24.73	30.82	37.59	45.02
250	.397	.567	.876	1.172	1.508	2.370	3.422	6.061	9.668	13.60	16.34	18.90	21.64	24.46	27.47	34.23	41.75	50.00
275	.437	.624	.964	1.289	1.659	2.607	3.765	6.669	10.64	14.97	17.98	20.79	23.81	26.91	30.22	37.66	45.94	55.02
300	0.477	0.681	1.051	1.406	1.811	2.845	4.108	7.277	11.61	16.33	19.62	22.69	25.98	29.37	32.97	41.10	50.12	60.03
325	.517	.737	1.139	1.523	1.961	3.081	4.449	7.881	12.57	17.69	21.24	24.57	28.14	31.80	35.71	44.51	54.28	65.01
350	.557	.794	1.227	1.641	2.112	3.318	4.792	8.488	13.54	19.05	22.88	26.46	30.31	34.26	38.47	47.94	58.47	70.02
375	.596	.851	1.314	1.758	2.263	3.556	5.135	9.096	14.51	20.41	24.52	28.36	32.48	36.71	41.22	51.37	62.65	75.04
400	0.636	0.908	1.402	1.875	2.414	3.792	5.476	9.700	15.47	21.77	26.15	30.24	34.63	39.15	43.96	54.78	66.81	80.02
425	.676	.965	1.489	1.992	2.565	4.029	5.819	10.31	16.44	23.13	27.79	32.13	36.80	41.60	46.71	58.21	71.00	85.03
450	.716	1.021	1.577	2.110	2.716	4.267	6.162	10.91	17.41	24.50	29.42	34.03	38.97	44.05	49.46	61.64	75.18	90.04
475	.755	1.078	1.664	2.226	2.866	4.503	6.503	11.52	18.37	25.85	31.05	35.91	41.13	46.49	52.20	65.05	79.34	95.03
500	0.795	1.135	1.752	2.344	3.017	4.741	6.846	12.13	19.34	27.22	32.69	37.81	43.30	48.94	54.95	68.49	83.53	100.0
525	.835	1.192	1.840	2.461	3.169	4.978	7.190	12.73	20.31	28.58	34.33	39.70	45.47	51.39	57.71	71.92	87.71	105.1
550	.875	1.248	1.927	2.578	3.318	5.214	7.531	13.34	21.27	29.93	35.96	41.58	47.62	53.83	60.44	75.33	91.87	110.0
575	.915	1.305	2.015	2.695	3.470	5.452	7.874	13.95	22.24	31.30	37.59	43.48	49.79	56.28	63.20	78.76	96.06	115.0
600	0.954	1.362	2.103	2.813	3.621	5.689	8.217	14.55	23.21	32.66	39.23	45.37	51.96	58.73	65.95	82.19	100.2	120.1
625	.994	1.418	2.190	2.929	3.772	5.925	8.558	15.16	24.18	34.02	40.86	47.25	54.12	61.17	68.69	85.60	104.4	125.0
650	1.034	1.475	2.278	3.047	3.923	6.163	8.901	15.76	25.14	35.38	42.50	49.15	56.29	63.62	71.44	89.03	108.6	130.1
675	1.074	1.532	2.366	3.164	4.074	6.401	9.244	16.37	26.11	36.74	44.14	51.04	58.46	66.07	74.19	92.46	112.8	135.1
700	1.113	1.589	2.453	3.281	4.224	6.637	9.585	16.98	27.08	38.10	45.76	52.93	60.61	68.51	76.93	95.88	116.9	140.0
725	1.153	1.646	2.541	3.398	4.375	6.874	9.928	17.58	28.05	39.46	47.40	54.82	62.78	70.96	79.68	99.31	121.1	145.1
750	1.193	1.702	2.628	3.515	4.526	7.110	10.27	18.19	29.01	40.82	49.03	56.70	64.94	73.40	82.42	102.7	125.3	150.0
775	1.233	1.759	2.716	3.633	4.677	7.348	10.61	18.80	29.98	42.18	50.67	58.60	67.11	75.85	85.17	106.1	129.5	155.1
800	1.272	1.816	2.804	3.750	4.828	7.585	10.95	19.40	30.95	43.55	52.31	60.49	69.28	78.31	87.93	109.6	133.6	160.1
825	1.312	1.872	2.891	3.867	4.978	7.821	11.30	20.01	31.91	44.90	53.93	62.37	71.43	80.74	90.66	113.0	137.8	165.1
850	1.352	1.929	2.979	3.984	5.130	8.059	11.64	20.61	32.88	46.27	55.57	64.27	73.60	83.19	93.42	116.4	142.0	170.1
875	1.392	1.986	3.067	4.102	5.281	8.296	11.98	21.22	33.85	47.63	57.21	66.16	75.77	85.65	96.17	119.9	146.2	175.1

Note: Volumes are based on an atmospheric pressure of 14.65 lb. per sq. in., uncorrected for deviation from Boyle's law.

Example: A section of 18-in. line is partly blown-down between two main line gates at Stations 1563+49 and 2083+65, respectively. Initial pressure on the section is 750 lb. per sq. in. Pressure on the line at the end of the blow is 175 lb. per sq. in. What is the volume of gas lost during the blowdown?

Solution: 208365 − 156349 = 52016 ft., or 52.016 M ft. of line.

Volume of gas lost in blowdown of 1000 ft. of 18-in. line from 750 lb. per sq. in. ga. to atmospheric pressure = 82.42 M cu. ft.

Volume of gas lost in blowdown of 1000 ft. of 18-in. line from 175 lb. per sq. in. ga. to atmospheric pressure = 19.24 M cu. ft.

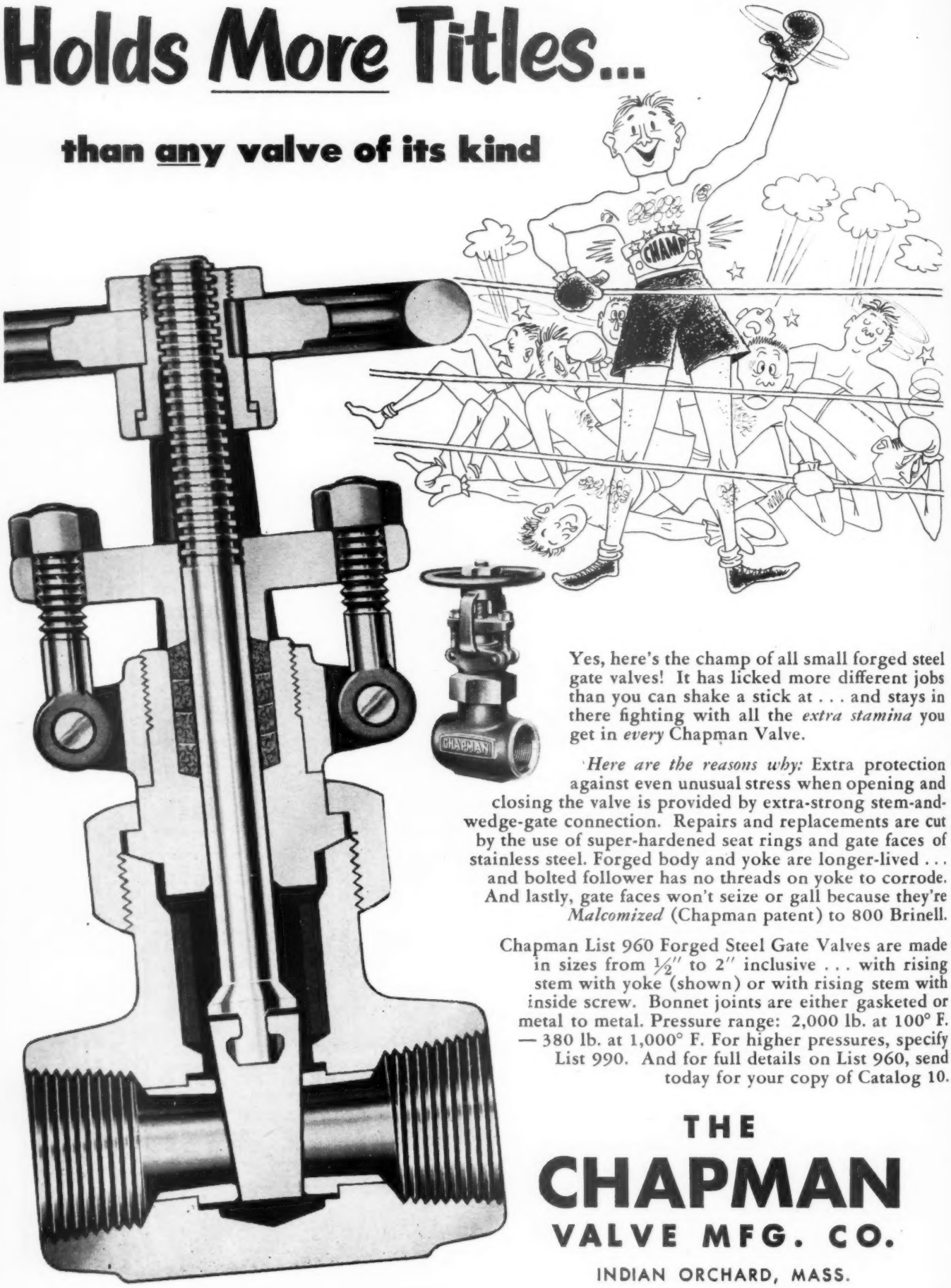
Volume of gas lost in blowdown of 1000 ft. of 18-in. line from 750 to 175 lb. per sq. in. ga. pressure = 63.18 M cu. ft.

63.18 times 52.016 = 3286.4 M cu. ft. of gas lost in blowdown

CHAPMAN LIST 960

Holds More Titles...

than any valve of its kind



Yes, here's the champ of all small forged steel gate valves! It has licked more different jobs than you can shake a stick at . . . and stays in there fighting with all the *extra stamina* you get in *every* Chapman Valve.

Here are the reasons why: Extra protection against even unusual stress when opening and closing the valve is provided by extra-strong stem-and-wedge-gate connection. Repairs and replacements are cut by the use of super-hardened seat rings and gate faces of stainless steel. Forged body and yoke are longer-lived . . . and bolted follower has no threads on yoke to corrode. And lastly, gate faces won't seize or gall because they're *Malcomized* (Chapman patent) to 800 Brinell.

Chapman List 960 Forged Steel Gate Valves are made in sizes from ½" to 2" inclusive . . . with rising stem with yoke (shown) or with rising stem with inside screw. Bonnet joints are either gasketed or metal to metal. Pressure range: 2,000 lb. at 100° F. — 380 lb. at 1,000° F. For higher pressures, specify List 990. And for full details on List 960, send today for your copy of Catalog 10.

THE CHAPMAN VALVE MFG. CO.

INDIAN ORCHARD, MASS.

VOLUME OF GAS LOST IN BLOWDOWN OF LINE

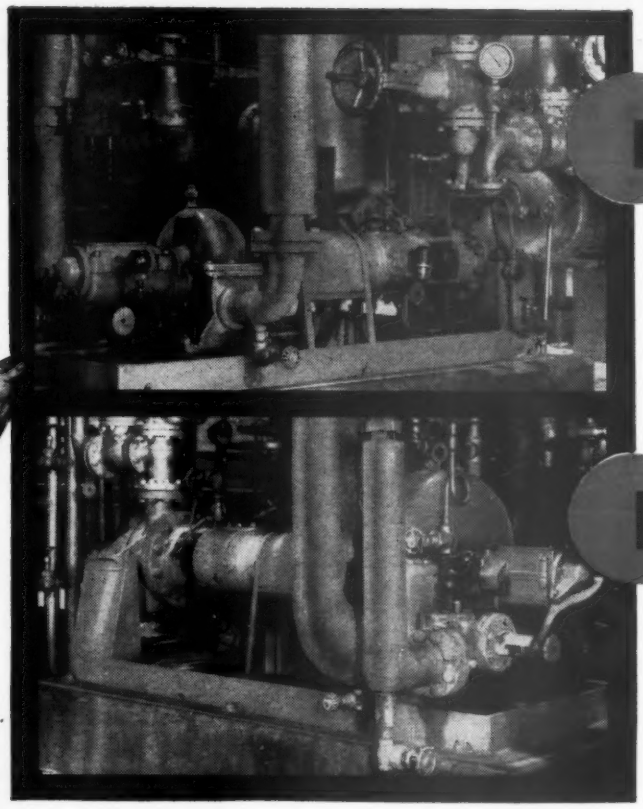
(Gas volumes in table are in M cu. ft. per 1000 ft. of line)

Initial line pressure on shut-in section, lb. per sq. in., ga.	Nominal diameter of line, in.																	
	2	2½	3	3½	4	5	6	8	10	12	14	15	16	17	18	20	22	24
900	1.431	2.042	3.154	4.218	5.431	8.534	12.32	21.58	34.41	48.62	58.84	68.05	77.93	88.08	98.91	123.3	149.0	178.7
925	1.471	2.099	3.242	4.335	5.582	8.771	12.66	22.18	35.37	49.97	60.47	69.94	80.09	90.53	101.7	126.7	153.1	183.7
950	1.511	2.156	3.329	4.452	5.733	9.008	13.00	22.78	36,32	51.32	62.11	71.83	82.26	92.97	104.4	130.1	157.3	188.6
975	1.551	2.213	3.417	4.569	5.884	9.245	13.35	23.39	37.28	52.67	63.74	73.72	84.42	95.42	107.2	133.6	161.4	193.6
1000	1.590	2.269	3.504	4.686	6.035	9.482	13.69	23.98	38.23	54.02	65.38	75.61	86.59	97.87	109.9	137.0	165.6	198.6
1025	1.630	2.326	3.592	4.804	6.185	9.719	14.03	24.58	39.19	55.37	67.01	77.50	88.75	100.3	112.6	140.4	169.7	203.5
1050	1.670	2.383	3.680	4.921	6.336	9.956	14.37	25.18	40.15	56.72	68.65	79.39	90.92	102.8	115.4	143.8	173.8	208.5
1075	1.710	2.439	3.767	5.038	6.487	10.19	14.72	25.78	41.10	58.07	70.28	81.28	93.08	105.2	118.1	147.3	178.0	213.4
1100	1.749	2.496	3.855	5.155	6.638	10.43	15.06	26.38	42.06	59.42	71.92	83.17	95.25	107.7	120.9	150.7	182.1	218.4
1125	1.789	2.553	3.942	5.272	6.789	10.67	15.40	26.98	43.01	60.77	73.55	85.06	94.41	110.1	123.6	154.1	186.3	223.4
1150	1.829	2.610	4.030	5.389	6.940	10.90	15.74	27.58	43.97	62.13	75.18	86.95	99.58	112.5	126.4	157.5	190.4	228.3
1175	1.869	2.667	4.118	5.516	7.091	11.14	16.09	28.18	44.92	63.48	76.82	88.84	101.7	115.0	129.1	161.0	194.5	233.3
1200	1.908	2.723	4.205	5.623	7.242	11.38	16.43	28.78	45.88	64.83	78.45	90.73	103.9	117.4	131.9	164.4	198.7	238.3
1225	1.948	2.780	4.293	5.740	7.392	11.62	16.77	29.37	46.84	66.18	80.09	92.62	106.1	119.9	134.6	167.8	202.8	243.2
1250	1.988	2.836	4.380	5.857	7.543	11.85	17.11	29.97	47.79	67.53	81.71	94.51	108.2	122.3	137.4	171.2	207.0	248.2
1275	2.028	2.893	4.468	5.975	7.694	12.09	17.46	30.57	48.75	68.88	83.36	96.40	110.4	124.8	140.1	174.7	211.1	253.1
1300	2.067	2.950	4.556	6.092	7.845	12.33	17.80	31.17	49.70	70.23	84.99	98.29	112.6	127.2	142.9	178.1	215.2	258.1
1325	2.107	3.007	4.643	6.209	7.996	12.56	18.14	31.77	50.66	71.58	86.63	100.2	114.7	129.7	145.6	181.5	219.4	263.1
1350	2.147	3.064	4.731	6.326	8.147	12.80	18.48	32.37	51.62	72.93	88.26	102.1	116.9	132.1	148.4	184.9	223.5	268.0
1375	2.186	3.120	4.818	6.443	8.298	13.04	18.82	32.97	52.57	74.28	89.89	104.0	119.1	134.6	151.1	188.4	227.7	273.0
1400	2.226	3.177	4.906	6.560	8.449	13.28	19.17	33.57	53.53	75.63	91.53	105.9	121.2	137.0	153.9	191.8	231.8	278.0
1425	2.266	3.234	4.994	6.677	8.599	13.51	19.51	34.17	54.48	76.98	93.16	107.7	123.4	139.5	156.6	195.2	235.9	282.9
1450	2.306	3.290	5.081	6.794	8.750	13.75	19.85	34.77	55.44	78.33	94.80	109.6	125.6	141.9	159.4	198.6	240.1	287.9
1475	2.346	3.348	5.169	6.915	8.901	13.99	20.19	35.38	56.41	79.69	96.44	111.5	127.7	144.4	162.1	202.1	244.3	292.8

Note: Volumes are based on an atmospheric pressure of 14.65 lb. per sq. in., uncorrected for deviation from Boyle's law.
Values for large-diameter lines at these high pressures are included, looking to the time when they will be needed in actual practice.

Example: A 4864-ft. section of 4-in. is partly blown-down from an initial pressure of 1275 lb. per sq. in. Pressure at the end of the blow is 375 lb. per sq. in. What is the volume of gas lost during the blowdown?

Solution:
Volume of gas lost in blowdown of 1000 ft. of 4-in. line from 1275 lb. per sq. in. ga. to atmospheric pressure = 7.694 M cu. ft.
Volume of gas lost in blowdown of 1000 ft. of 4-in. line from 375 lb. per sq. in. ga. to atmospheric pressure = 2.263 M cu. ft.
Volume of gas lost in blowdown of 1000 ft. of 4-in. line from 1275 to 375 lb. per sq. in. ga. pressure = 5.431 M cu. ft.
5.431 × 4.864 = 26.416 M cu. ft. of gas lost in blowdown.



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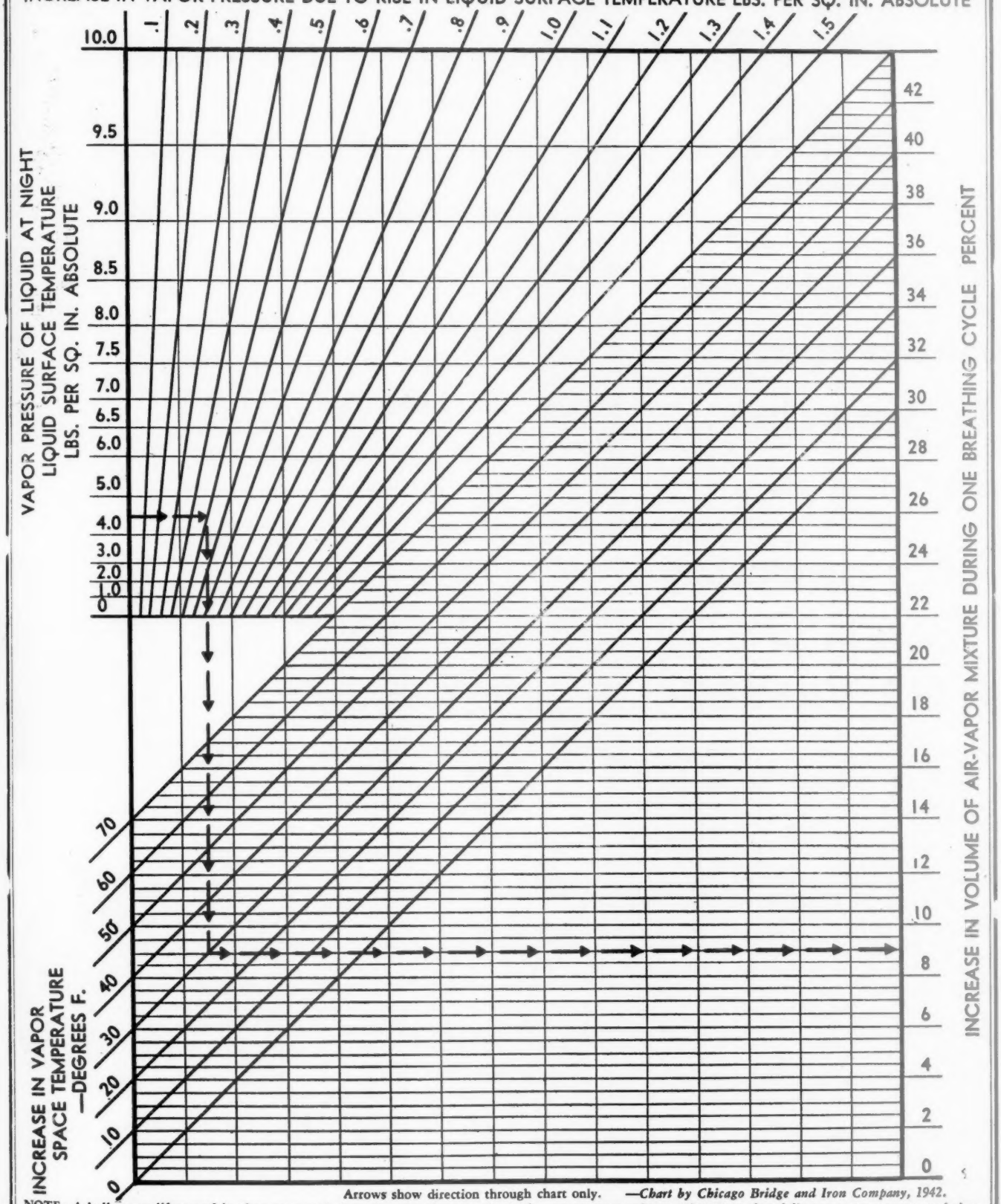
EXPANSION OF AIR-VAPOR MIXTURES IN ATMOSPHERIC STORAGE TANKS



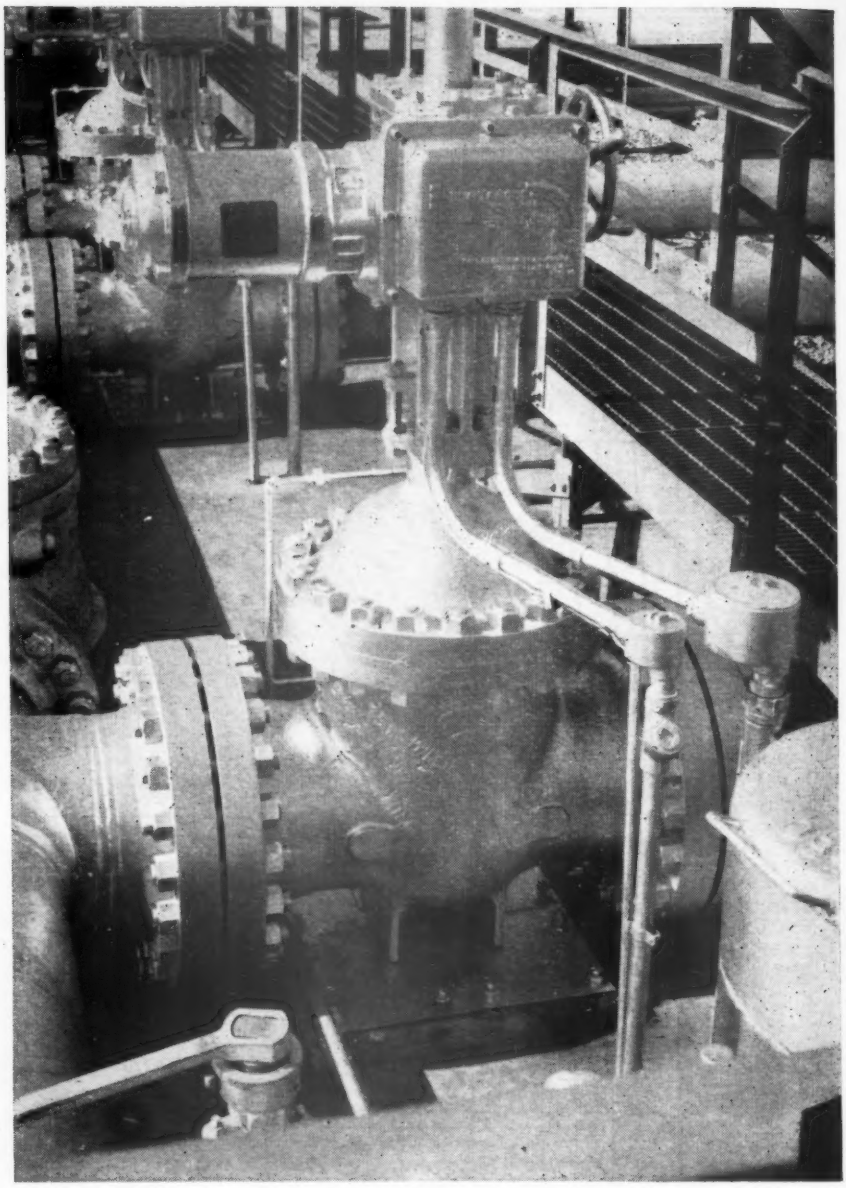
Arrows show direction through chart only. —*Chart by Chicago Bridge and Iron Company, 1942.*

NOTE: A balloon or lifter roof is often connected through vapor lines to adjacent tanks with cone roofs, serving as a gasholder for the group of tanks. It is then necessary to estimate the probable expansion of the air-vapor mixture in all of the tanks under maximum temp. conditions to determine the volume of gasholder capacity required. This may be done by calculating each separately and totaling. *Example:* Find the volumetric expansion of the air-vapor mixture in an 80,000-bbl. storage tank if the product stored is 10 lb. R.V.P. gasoline; outage 20 ft.; vapor space volume, 240,000 cu. ft.; daily vapor space temp. variation, 40°F.; day liquid surface temp., 75°F.; and night liquid surface temp., 70°F. From Table P 640.1 vapor pressure at 75°F. is 6.9 lb. per sq. in. abs. and at 70°F. is 6.3 lb. per sq. in. abs. The increase in vapor pressure is 0.6 lb. Enter the above chart from the left at 6.3 lb., across to 0.6 lb. increase, down to 40° vapor space temp. variation, and then across to the right to the estimated expansion of 12.7 percent. The total expansion is 240,000 × 0.127 = 30,500 cu. ft.

DARLING VALVES

How they cut down time in pipe line service . . .

with DARLING Revolving Disc GATE VALVES



Electrically operated 16" x 12" x 16" venturi-type Darling fully revolving double disc parallel seat *gate valves on a main line station.*

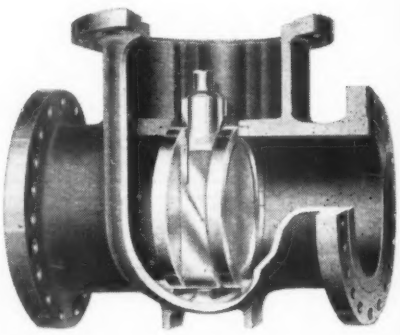
"What a difference!" . . . That's an expression often heard after Darling *fully revolving double disc parallel seat* gate valves go on the job.

In applications like this, these unique Darling valves show off their advantages well.

For example, Darling revolving disc gate valves successfully compensate for valve body distortion . . . they close tight every time! In addition, wear on discs and seats is *uniform.* These important parts just naturally last longer. After years of trouble-free operation should it become necessary to service the valves, the four working parts can be replaced on the spot . . . without removing the valves from the line.

GET ALL THE FACTS

Darling valve users are our best salesmen . . . we invite you to check with them. In the meantime let us send you a descriptive bulletin giving cost-saving facts. Just outline your specific service needs. State whether you are interested in main line, gathering, tank farm or other gas and oil line service. Darling valves can save you a lot of costly, time-wasting valve trouble in the future.



Cutaway showing complete simplicity of the Darling fully revolving double disc parallel seat *cast steel gate valve. Notice the four working parts . . . two interchangeable, no-pocket discs and two husky wedges. Maintenance is easy, assembly foolproof.*

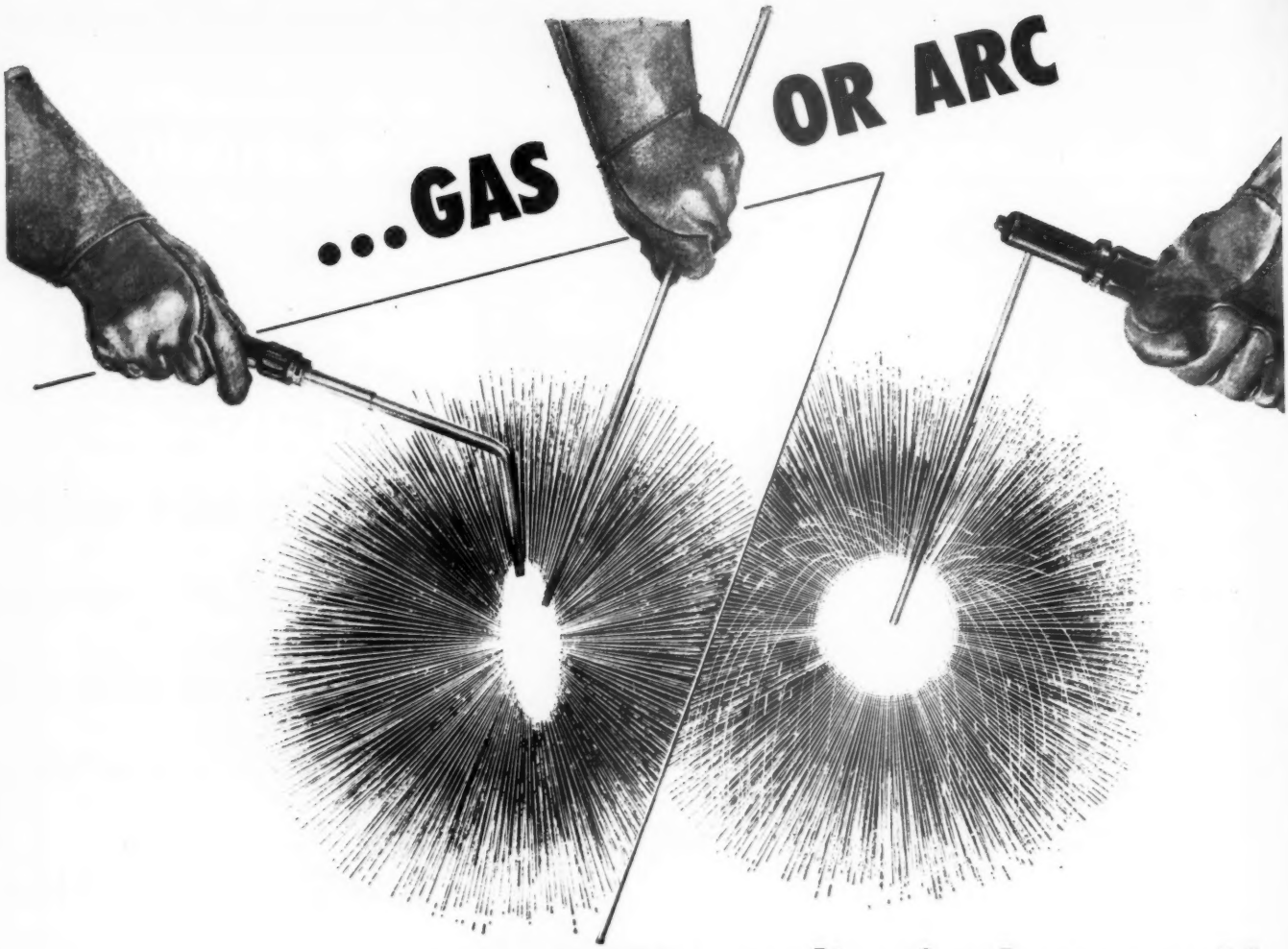
DARLING VALVE & MANUFACTURING CO.

Williamsport 2, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario

SPECIFIC GRAVITY OF SULPHURIC ACID SOLUTIONS AT VARIOUS TEMPERATURES

Weight percent of H_2SO_4	Temperature of solution										
	0° C 32° F	10° C 50° F	15° C 59° F	20° C 68° F	25° C 77° F	30° C 86° F	40° C 104° F	50° C 122° F	60° C 140° F	80° C 176° F	100 °C 212° F
1	1.0074	1.0068	1.0060	1.0051	1.0038	1.0022	0.9986	0.9944	0.9895	0.9779	0.9645
2	1.0147	1.0138	1.0129	1.0118	1.0104	1.0087	1.0050	1.0006	0.9956	0.9839	0.9705
3	1.0219	1.0206	1.0197	1.0184	1.0169	1.0152	1.0113	1.0067	1.0017	0.9900	0.9766
4	1.0291	1.0275	1.0264	1.0250	1.0234	1.0216	1.0176	1.0129	1.0078	0.9961	0.9827
5	1.0364	1.0344	1.0332	1.0317	1.0300	1.0281	1.0240	1.0192	1.0140	1.0022	0.9888
6	1.0437	1.0414	1.0400	1.0385	1.0367	1.0347	1.0305	1.0256	1.0203	1.0084	0.9950
7	1.0511	1.0485	1.0469	1.0453	1.0434	1.0414	1.0371	1.0321	1.0266	1.0146	1.0013
8	1.0585	1.0556	1.0539	1.0522	1.0502	1.0481	1.0437	1.0386	1.0330	1.0209	1.0076
9	1.0660	1.0628	1.0610	1.0591	1.0571	1.0549	1.0503	1.0451	1.0395	1.0273	1.0140
10	1.0735	1.0700	1.0681	1.0661	1.0640	1.0617	1.0570	1.0517	1.0460	1.0338	1.0204
11	1.0810	1.0773	1.0753	1.0731	1.0710	1.0686	1.0637	1.0584	1.0526	1.0403	1.0269
12	1.0886	1.0846	1.0825	1.0802	1.0780	1.0756	1.0705	1.0651	1.0593	1.0469	1.0335
13	1.0962	1.0920	1.0898	1.0874	1.0851	1.0826	1.0774	1.0719	1.0661	1.0536	1.0402
14	1.1039	1.0994	1.0971	1.0947	1.0922	1.0897	1.0844	1.0788	1.0729	1.0603	1.0469
15	1.1116	1.1069	1.1045	1.1020	1.0994	1.0968	1.0914	1.0857	1.0798	1.0671	1.0537
16	1.1194	1.1145	1.1120	1.1094	1.1067	1.1040	1.0985	1.0927	1.0868	1.0740	1.0605
17	1.1272	1.1221	1.1195	1.1168	1.1141	1.1113	1.1057	1.0998	1.0938	1.0809	1.0674
18	1.1351	1.1298	1.1271	1.1243	1.1215	1.1187	1.1129	1.1070	1.1009	1.0879	1.0744
19	1.1430	1.1375	1.1347	1.1318	1.1290	1.1261	1.1202	1.1142	1.1081	1.0950	1.0814
20	1.1510	1.1453	1.1424	1.1394	1.1365	1.1335	1.1275	1.1215	1.1153	1.1021	1.0885
21	1.1590	1.1531	1.1501	1.1471	1.1441	1.1410	1.1349	1.1288	1.1226	1.1093	1.0957
22	1.1670	1.1609	1.1579	1.1548	1.1517	1.1485	1.1424	1.1362	1.1299	1.1166	1.1029
23	1.1751	1.1688	1.1657	1.1626	1.1594	1.1563	1.1500	1.1437	1.1373	1.1239	1.1102
24	1.1832	1.1768	1.1736	1.1704	1.1672	1.1640	1.1576	1.1512	1.1448	1.1313	1.1176
25	1.1914	1.1848	1.1816	1.1783	1.1750	1.1718	1.1653	1.1588	1.1523	1.1388	1.1250
26	1.1996	1.1929	1.1896	1.1862	1.1829	1.1796	1.1730	1.1665	1.1599	1.1463	1.1325
27	1.2078	1.2010	1.1976	1.1942	1.1909	1.1875	1.1808	1.1742	1.1676	1.1539	1.1400
28	1.2160	1.2091	1.2057	1.2023	1.1989	1.1955	1.1887	1.1820	1.1753	1.1616	1.1476
29	1.2243	1.2173	1.2138	1.2104	1.2069	1.2035	1.1966	1.1898	1.1831	1.1693	1.1553
30	1.2326	1.2255	1.2220	1.2185	1.2150	1.2115	1.2046	1.1977	1.1909	1.1771	1.1630
31	1.2409	1.2338	1.2302	1.2267	1.2232	1.2196	1.2126	1.2057	1.1988	1.1849	1.1708
32	1.2493	1.2421	1.2385	1.2349	1.2314	1.2278	1.2207	1.2137	1.2068	1.1928	1.1787
33	1.2577	1.2504	1.2468	1.2432	1.2396	1.2360	1.2289	1.2218	1.2148	1.2008	1.1866
34	1.2661	1.2588	1.2552	1.2515	1.2479	1.2443	1.2371	1.2300	1.2229	1.2088	1.1946
35	1.2746	1.2672	1.2636	1.2599	1.2563	1.2526	1.2454	1.2383	1.2311	1.2169	1.2027
36	1.2831	1.2757	1.2720	1.2684	1.2647	1.2610	1.2538	1.2466	1.2394	1.2251	1.2109
37	1.2917	1.2843	1.2805	1.2769	1.2732	1.2695	1.2622	1.2550	1.2477	1.2334	1.2192
38	1.3004	1.2929	1.2891	1.2855	1.2818	1.2780	1.2707	1.2635	1.2561	1.2418	1.2276
39	1.3091	1.3016	1.2978	1.2941	1.2904	1.2866	1.2793	1.2720	1.2646	1.2503	1.2361
40	1.3179	1.3103	1.3065	1.3028	1.2991	1.2953	1.2880	1.2806	1.2732	1.2589	1.2446
41	1.3268	1.3191	1.3153	1.3116	1.3079	1.3041	1.2967	1.2893	1.2819	1.2675	1.2532
42	1.3357	1.3280	1.3242	1.3205	1.3167	1.3129	1.3055	1.2981	1.2907	1.2762	1.2619
43	1.3447	1.3370	1.3332	1.3294	1.3256	1.3218	1.3144	1.3070	1.2996	1.2850	1.2707
44	1.3538	1.3461	1.3423	1.3384	1.3346	1.3308	1.3234	1.3160	1.3086	1.2939	1.2796
45	1.3630	1.3553	1.3515	1.3476	1.3437	1.3399	1.3325	1.3251	1.3177	1.3029	1.2886
46	1.3724	1.3646	1.3608	1.3569	1.3530	1.3492	1.3417	1.3343	1.3269	1.3120	1.2976
47	1.3819	1.3740	1.3702	1.3663	1.3624	1.3586	1.3510	1.3435	1.3362	1.3212	1.3067
48	1.3915	1.3835	1.3797	1.3758	1.3719	1.3680	1.3604	1.3528	1.3455	1.3305	1.3159
49	1.4012	1.3931	1.3893	1.3854	1.3814	1.3775	1.3699	1.3623	1.3549	1.3399	1.3253
50	1.4110	1.4029	1.3990	1.3951	1.3911	1.3872	1.3795	1.3719	1.3644	1.3494	1.3348



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SOLUTION OF OLIPHANT'S FORMULA FOR GAS FLOW IN VACUUM AND PRESSURE LINES FOR GASOLINE PLANTS

Q = discharge cu. ft. per day $Q = 1008\,(A)$

A = function of diameter in in.

$$= D^{8/3} + \frac{D^{8}}{30}\sqrt{\frac{P_1^2 - P_2^2}{L}}\sqrt{\frac{0.6}{G}}$$

P_1 = initial pressure } lb. per sq. in. abs.
P_2 = final pressure }

L = length (miles)

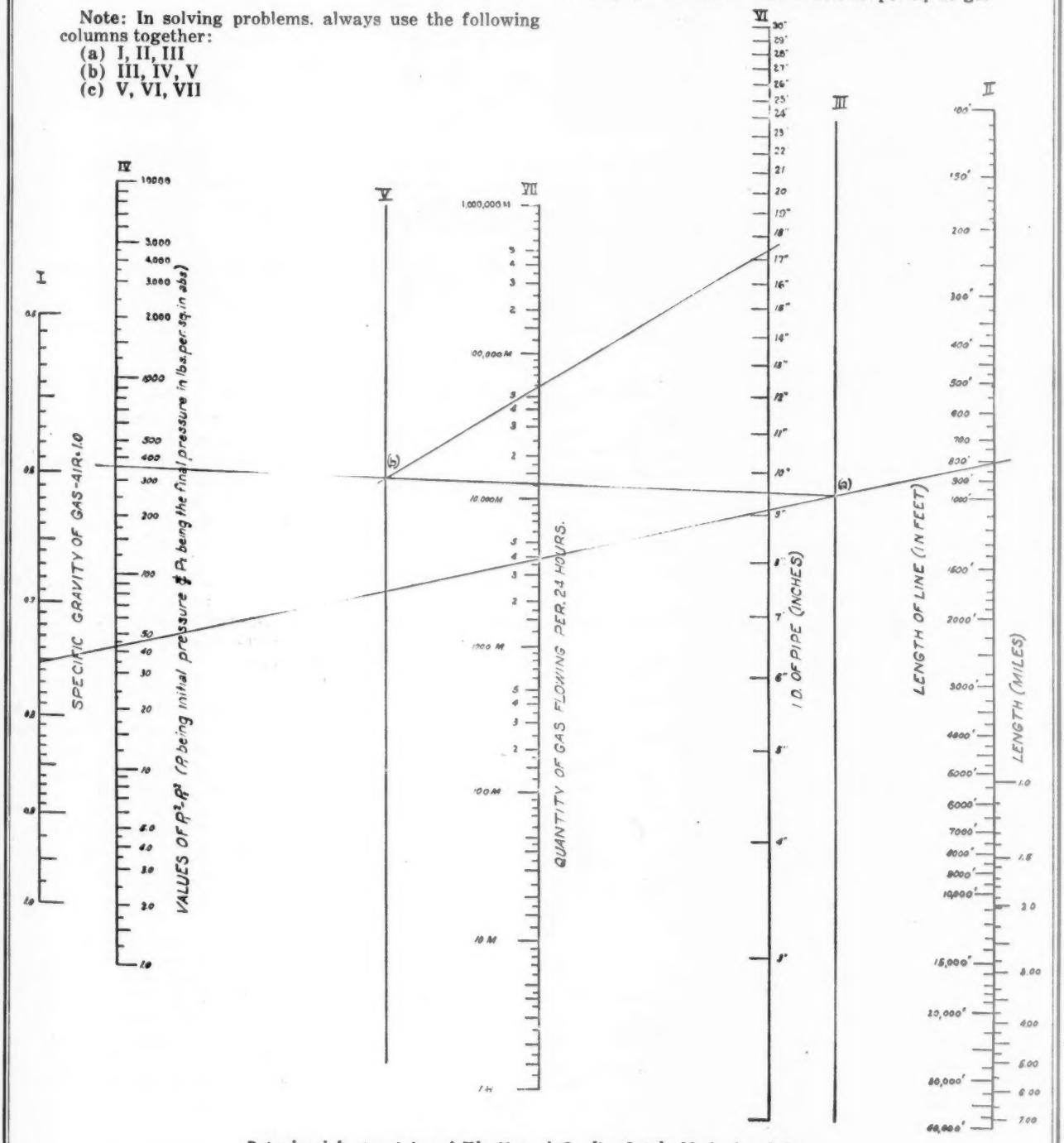
G = { specific gravity of gas / air = 1

Problem: $L = 800$ ft., $G = 0.75$, and internal diameter 18 in. pipe = 17.25 in.
$Q = 60{,}000{,}000$, and $P_2 = 25$ lb. gauge.

Required: P_1

Solution: Connect straight line through 0.75 on I and through 800 ft. on II, locating (a) on III.
Connect straight line through 17.25 on VI and through 60,000 M on VII, locating (b) on V.
Connect straight line through (a) and (b) to IV and find $P_1^2 - P_2^2 = 350$.
But $P_2 = 25$ lb. gauge or $25 + 14 = 39$ lb. in. abs.
$P_1^2 - P_2^2 = 350$
$P_1^2 = 350 + (39)^2 = 350 + 1521 = 1871$
$P_1 = \sqrt{1871} = 43.3 - 14.0 = 29.3$-lb. per sq. in. ga.

Note: In solving problems. always use the following columns together:
(a) I, II, III
(b) III, IV, V
(c) V, VI, VII



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LAUGH with BARNEY

A couple of old college pals met one day and were discussing this and that and finally got to the job subject.

"What type of work are you doing now, Jim?"

"Why, the usual advertising run, nothing extra. What's new with you?"

"Why, I hold the position as psychiatrist at a pottery factory."

"Psychiatrist at a pottery factory?"

"Yeah, I take care of the cracked pots."

* * *

Man is inclined, when in the wrong, to lay the blame on someone else. He is like the small boy who was standing on the cat's tail. The mother, hearing the terrible outburst, called from an adjoining room, "Tommy, stop pulling that cat's tail!" Tommy yelled back, "I'm not pulling the cat's tail; I'm only standing on it. He's the one that's doing the pulling."

* * *

Mose was brought up for the fourth speeding offense. He muttered under his breath something that sounded a lot like an oath.

"Repeat that!" snapped the judge.

"Ah says, 'God am de jedge, God am de jedge!'"

* * *

Sign on store housing bankrupt business venture—"Opened By Mistake."

"Just don't get discouraged," warned Miss Beaver, "the world has a man for every girl and a girl for every man. You can't improve on that."

"I don't want to improve on it," said Miss Eager, "I just want to get in on it."

* * *

An off-day is usually something that follows a day off.—Fifth Wheel.

* * *

Conscience is the still, small voice that tells you somebody's looking.

* * *

A man was seated on a park bench when a little chap about five sat down beside him and started winding what appeared to be a most prized possession — a dollar watch.

"My, what a pretty watch," the man remarked. "Does it tell you the time?"

"No, sir," replied the little fellow, "you gotta look at it."

* * *

A Scotsman, dressed in a kilt, was standing on the platform of a railroad station in Glasgow when a friend came along. "Where are ye bound for, Jock?" asked the friend.

"I'm going to Edinboro' on my honeymoon," said Jock.

"And where is the lucky bride?"

"Am no' taking her," said the bridegroom. "She's been there."

"It's oil, young lady ... LANE-WELLS on the job"

After his talk to the Sunday School class, the minister asked if there were any questions. And a shrill voice piped out: "Please, sir, why did the angels walk up and down Jacob's ladder when they had wings?' "Ah, I see," said the minister. "Now would anyone like to answer that question?"

* * *

Gal: "I wonder what came over that nice-looking fellow over there. He kissed me, then turned pale and walked away."

Sal: "Maybe he saw me come in. I'm his wife."

* * *

People are like steamboats—they toot loudest when they are in a fog.—Friendly Thoughts.

* * *

A Frenchman was relating his experience in studying the English language. He said: "When I first discovered that if I was quick, I was fast; that if I was tied, I was fast; if I spent too freely, I was fast; and that not to eat was fast, I was discouraged. But when I came across the sentence, 'The first one won one one-dollar prize,' I gave up trying."

* * *

"Tommy's broken my new doll," said the little girl to her mother.

"And how did he do that, dear?"

"I hit him on the head with it."

* * *

The lady's husband on the train had left her to go to the smoking car. After he had been gone for more than an hour, she went forward to look for him. When she entered the smoking room, it was almost deserted, but in the center of the car she spotted his bald head. She quietly approached from the rear, kissed him on the bald spot and said, "Hello, honey."

The man looked up in surprise, and of course, it was not her husband.

She threw up her hands, saying, "Oh, I am sorry. The top of your head looks just like my husband's, behind."

* * *

A couple of young boys walked into the dentist's office and one faced boldly up to the dentist and said, "Doc, I want a tooth took out and I don't want no gas 'cause I'm in a hurry."

"My," said the doc, "I must say you're a brave boy. Which tooth is it?"

The little boy turned to his silent friend and said, "Show him your tooth, Albert."

* * *

A Scotch lad was showing a woman tourist an old abbey, and on leaving him at the churchyard gate, she rewarded him only with verbal thanks, whereupon the canny Scotman remarked:

"Well, leddy, when ye gang home, in ye fin' oot that ye have lost your purse, ye maun recollect that ye havna had it oot here."

* * *

"To err is only human, but when you wear out the eraser before you've used up the pencil, you are overdoing it."

OIL and GAS TRADE NEWS

Continental Supply Builds New Casper Headquarters

Construction has begun on new Casper, Wyoming, headquarters for The Continental Supply Company. A new building, on Highway 20 at the east edge of Casper, will house the oil-field-supply company's store and warehouse, and district headquarters for its entire Rocky Mountain operations.

In addition to the present construction, Continental recently announced plans for a new store building in Williston, North Dakota, where they have operated since 1952. The store building used in the company's 1953 International Petroleum Exhibition in Tulsa, Oklahoma, is being moved to Williston.

BIF Changes Name

Builders Iron Foundry is to become B-I-F Industries, Inc. The name Builders Iron Foundry was adopted in 1853, when the company was incorporated. Then it was appropriate, since its business was making castings for the building trades. When in the '90's the company began the manufacture of meters, it was still appropriate as the Venturi tubes and even the instruments were largely of cast iron. Today more parts come from the sheet metal shop than from the foundry.

New Lane-Wells Offices

Lane-Wells has established a truck station at Graham, Texas, with W. D. Capper as station superintendent.

A Lane-Wells district sales office has been established at 910 Carondolet Building in downtown New Orleans, Louisiana. W. B. Vice, Jr., is in charge.

Export Agents Named

Lorum Fibre Company, Inc., has appointed the Val R. Wittich organization as export representatives for "Leather Fibre," a drilling fluid additive for combatting lost circulation. Fred J. Jobst, sales engineer, and Clay H. Hesse, sales assistant, will handle the account.

Davis Appoints Agent

Davis Instruments, division of Davis Emergency Equipment Company has named Industrial Scientific, Inc., as their representative to handle Davis Instruments in Texas, Southern Louisiana, and parts of New Mexico. B. H. Wilson is president of Industrial Scientific, at 1014 Taylor Street, Fort Worth; Roy E. O'Neill, secretary-treasurer, at 317 Nagle Street, Houston, Texas.

New Outlet for Cleco Tools

Cleco Pneumatic Tool Division of Reed Roller Bit Company, Houston, Texas, has just announced the appointment of Mine and Mill Machinery Company of Los Angeles, California, as distributor for Cleco products in its area.

Dowell Opens Denver Office

The expansion program begun by Dowell in the Rocky Mountain region nearly 3 years ago now includes the organization of its Denver district with headquarters in the Patterson Building. The announcement of the new district

E. H. Nielsen

W. J. Buehler

was made by A. C. Polk, Jr., general manager at Tulsa where Dowell has its prinicpal offices, laboratories, and shops.

States included in the Denver district are Montana, North and South Dakota, Wyoming, Colorado, Utah and Northern New Mexico. All the activities of the company in this area will be directed from the Denver office.

The new district will be managed by Emery H. Nielsen, formerly assistant manager at Wichita. An engineering graduate of Oklahoma University, Nielsen has been with Dowell since 1944.

Dowell is transferring from its Tulsa headquarters William J. Buehler who will be district office manager. He has been a member of the Tulsa general office since 1945 and for the past 2 years has been billing supervisor.

Other key men who will assist Nielsen in the district operation will be Alfred Gionta, area engineer, Casper; J .A. McClure, area engineer, Williston; W. C. Gibbs, sales engineer, Sterling, and H. A. Riggs, sales engineer, Vernal.

Mechanical Seals Film Out

Byron Jackson Company has just completed a full-color educational film describing the theory, purpose, use, construction, and maintenance of mechanical seals. This factual film is available for showing to company engineering and maintenance meetings. Write direct to: L. E. Kimball. Byron Jackson, Los Angeles 54, California.

Tube Turns Establishes Branch Plant in Houston

Tube Turns, Inc., has established a branch plant in Houston, Texas, to provide special service to the Southwest's petroleum industry. The new plant, of modern design, is at 7120 Katy Highway. All operations are in charge of W. B. Whenthoff, Tube Turns' district manager. District offices, formerly in the Commerce Building, have been moved to the plant.

New Firm To Handle SHMCO Products' Sales

Glenn Blackmann, S. I. (Sam) Pattillo, and Thad L. Putnam have announced organization of Continental Sales, Inc., for the purpose of handling distribution of products manufactured by SHMCO Valves, Inc., of South Houston, Texas.

The manufacturing firm, formerly known as South Houston Machine Works, Inc., manufactures non-slam and conventional pipe line check valves and other products for the drilling, production and pipe line industries.

Columbia Southern Will Build Ammonia Plant

Columbia-Southern Chemical Corporation will enter the ammonia production field, it was revealed recently. E. T. Asplundh, president, said that the firm plans to construct its first ammonia producing facility soon at Natrium, West Virginia. Contracts for the construction work will be let in the near future and the firm expects to be in production by late 1954.

Graver Opens LA Office

W. M. Broxham, vice president for sales of the Graver Tank and Manufacturing Company, Inc., announces the opening of a sales engineering office in Los Angeles at 1250 Wilshire.

The Los Angeles office will be under the direction of William T. Hudson, manager of the new Graver plant at Casper, Wyoming. District sales manager for the Los Angeles office will be Hubbert L. O'Brien.

IBM Film Available

Piercing the Unknown, a new 16-mm color-sound motion picture that may be borrowed free of charge from International Business Machines Corporation, traces the development of computing devices up through the IBM Electronic Data Processing Machines, IBM's latest "giant brain." The film stresses the need for machines to perform mathematical computations and repetitive data handling operations so that men's minds can be free for creative thinking.

The film may be booked through any IBM branch office, or write, stating dates, to the Department of Education, International Business Machines Corporation, Endicott, New York.

Edward Notes Birthday

This anniversary year, of Edward Valves, Inc., was marked by the coordination of all engineering and research activities under the supervision of L. H. Carr and by the completion of new buildings and the installation of testing equipment for designing and building valves for the highest presure-temperature plants now being designed.

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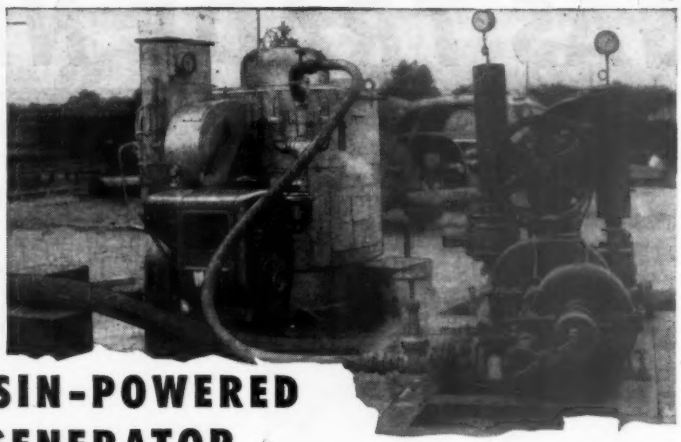

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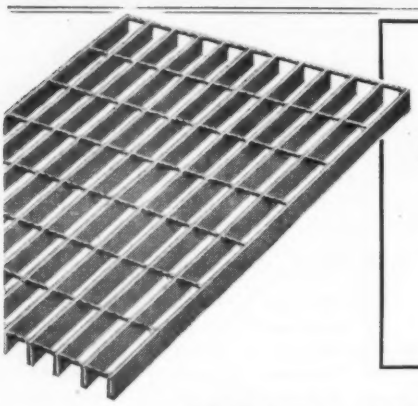

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Trade News

Buckeye To Distribute Carter Pumping Units

The Buckeye Supply Company will distribute Carter hydraulic pumping units in West Virginia. S. C. Carter Co. Inc., Los Angeles manufacturers of the Carter long-stroke hydraulic pumping unit, announces the appointment of The Buckeye Supply Company as distributors for the state of West Virginia.

The Buckeye Supply Company will handle sales and service of the Carter units from their head office at Zanesville and office at Vienna.

National Safety Award To Davison Publication

George W. Elste, president of the Baltimore Safety Council, on behalf of the National Safety Council, recently presented an award of merit to "The Davison Sentinel," safety magazine for employees, in recognition of "exceptional service in the promotion of safety." This is the second consecutive year the award has been given.

Miss Helen O'Hara, editorial assistant to A. B. Pettit, the company's supervisor of industrial health and safety, accepted the award. Marlin G. Geiger, vice chairman of the board, was also present.

New Subsidiary Announced

Establishment of Aero Service Corporation (Mid-Continent) at Tulsa, Oklahoma, was announced by Aero Service Corporation, Philadelphia, the parent company. The new organization, formerly Frost Airborne Surveys Corporation, will offer a greatly expanded aerial exploration and mapping service in the central United States.

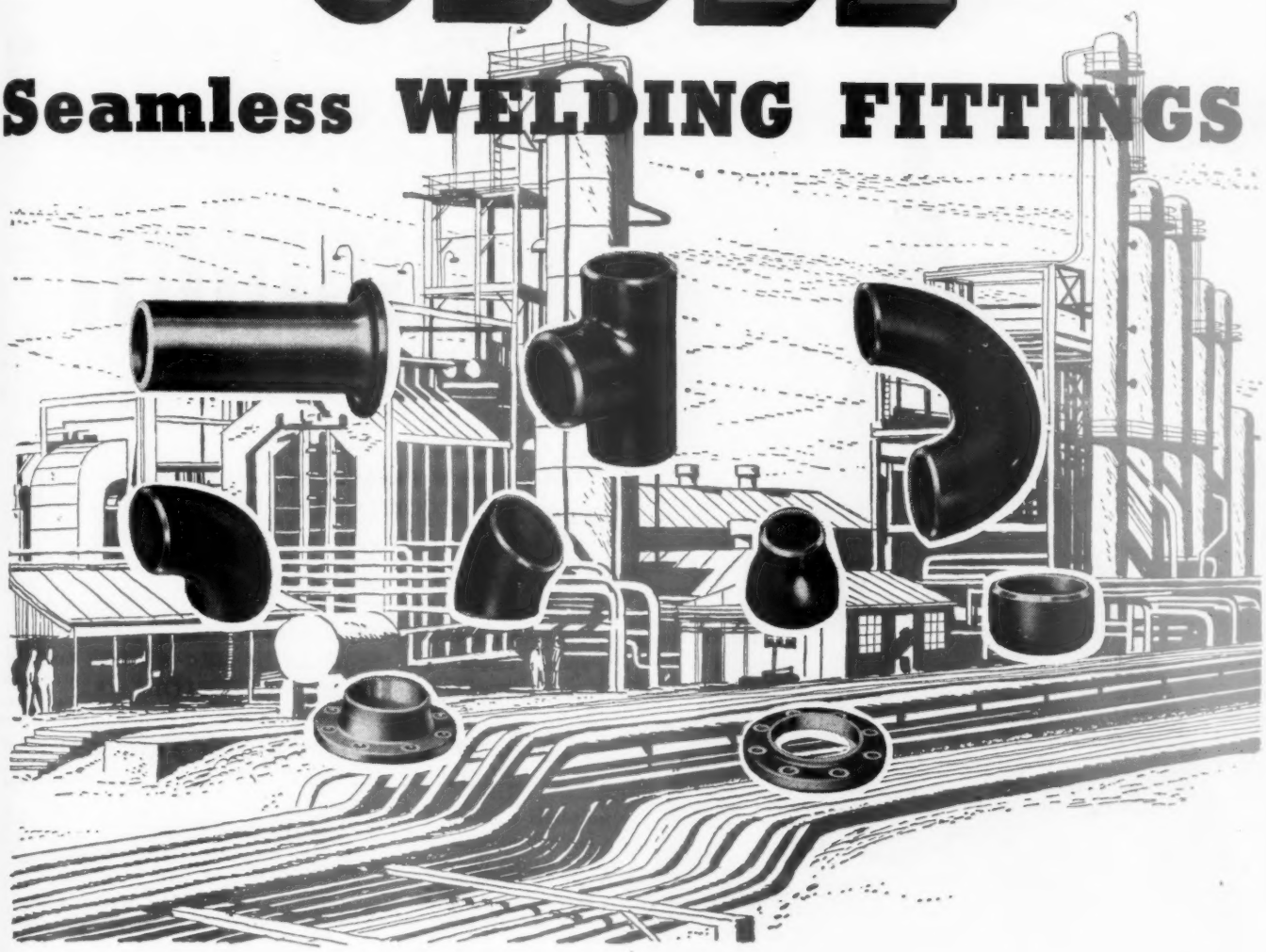
Personnel of the Frost organization has been retained in the new company. J. C. Rollins will head the sales department, and Al Ibach will be in charge of production. C. H. Frost will be available as a consultant to the new firm. William B. Agocs, formerly head of the department of geophysics of the University of Tulsa and formerly chief geophysicist for the parent firm, will be available as consultant. New personnel will also be added to the Aero (Mid-Continent) staff to handle the expanded operations of the company.

Denver Sample Log Opens Montana Office

Joe E. Guyer, president, Denver Sample Log Company, announces an expansion of the company's facilities to provide for the development and distribution of sample logs of important wildcats being drilled in Montana, North and South Dakota. A new office has been opened in Billings, Montana, under the direction of Dale Wallington, former manager of the company's Canadian branch in Regina, Saskatchewan. Wallington will be assisted in stratigraphy by J. W. Skrabanek. Skrabanek was previously employed by a consulting firm in Midland, Texas, also worked for University Lands in West Texas.

GLOBE

Seamless WELDING FITTINGS



The only seamless welding fittings precision-processed . . . from billet . . . to tube . . . to fitting

From charging the specially designed revolving furnace with a steel billet (above) through the many succeeding steps of production, every Globe process is specialized to produce fittings of unvarying quality.

Globe precision-process manufacture begins with the billet —continues through the making of the seamless steel tube (Globe alone among welding fittings manufacturers produces seamless steel tubes)—and extends through to the production of the finished fittings.

Because Globe has highly specialized controls—at every stage of manufacture at its own plant—you can be sure of uniform high quality seamless welding fittings when you specify Globe.

Send for the Globe Welding Fittings complete catalog.

GLOBE STEEL TUBES CO.,
Milwaukee 46, Wisconsin

Chicago • Cleveland • Detroit • New York • Philadelphia • St. Louis • Denver • Houston • San Francisco
Glendale, Cal.

Producers of Globe Welding Fittings — Globe seamless stainless steel tubes — alloy-carbon seamless steel tubes — Gloweld welded stainless steel tubes — Globeiron (high purity ingot iron) seamless tubes.

AVAILABLE IN A COMPLETE LINE OF SIZES AND WEIGHTS THROUGH GLOBE DISTRIBUTORS IN ALL KEY CITIES

~~emulsified oils~~ easily removed and recovered from waste water

with

BULKLEY-DUNTON

colloidair

SEPARATORS

POLLUTION PROBLEMS are easily, economically solved with a COLLOIDAIR. This famous dissolved air flotation unit removes and recovers oil from production or refining effluent... prevents rainbow in disposal waters... enables re-use of water in selected circuits... and is compactly designed to occupy minimum space. You'll meet the most rigid state, regional, and local pollution requirements with COLLOIDAIR.

LOOK AT THESE EFFICIENCY RATINGS!

Typical operation	Parts per million Influent	Colloidair Effluent
Refinery effluent	82	7
	150	28
	232	12
Cooling tower circuit effluent	230	22
Drum wash	4290	23
Car wash	5180	17

BULKLEY-DUNTON offers a complete line of prefabricated systems for waste water treatment. Special equipment is also designed and supplied for specific requirements. And a full staff of engineers is always at your service. Write today for complete details!

BULKLEY-DUNTON PROCESSES, INC.

Dept. H-1, 295 Madison Ave., New York 17, N. Y.

Pacific Coast: Dept. H-1, Security Bldg., Pasadena, Calif.

TRADE PERSONALS

Hunter

Burke

Berg

Turner

Mike Hunter will assume full charge of Oil Center Tool Company's Rocky Mountain district which includes North Dakota, South Dakota, Montana, Wyoming, Nebraska, and eastern Colorado. **Walter Burke** is the new Southwest Texas district manager. His office will be in Corpus Christi. **George Berg** has been appointed district manager in the Houston office.

Henry R. Hogendobler, formerly industrial insulations sales manager of Owens-Corning Fiberglas Corporation, has been named vice president and general manager of the Fiberglas Contracting and Supply Company. He succeeds Lee R. Reeder who has resigned. Hogendboler is a 1930 graduate in electrical engineering of the University of Illinois.

R. G. Campbell and **H. H. Holmes** have been named sales engineers for American Meter Company. Campbell is now a representative with the Los Angeles office of the company and Holmes is now a representative of the company in Western Oklahoma and Kansas. Campbell was with Southern California Gas Company before joining American Meter. Holmes received his degree at the University of Texas.

Harry L. Holstrum, who has been associated with the Republic Creosoting Company and the Reilly Tar and Chemical Corporation at their Minneapolis, Minn., plant since 1924, has been appointed manager of the plant. He succeeds **A. E. Larkin,** who is retiring after 44 years.

Elliott M. Harold has been appointed branch plant manager of the New Orleans mixed fertilizer plant of The Davison Chemical Corporation to succeed **Henry Gaudet,** who is retiring as manager but continuing as a consultant. After positions with Erie and Texas and Pacific railroads and Fisk Tire, Harold came to Davison in 1929.

Willard D. Squires, former assistant to the controller of the Westinghouse Air Brake Company has been elected to the position of controller to succeed **George V. Myers** who resigned to take another position.

Don Turner, former attorney for Sohio Petroleum Company in St. Louis, is joining National Tank Company, Tulsa, as its general counsel and administrative assistant. Turner, a graduate of the University of Illinois and of St. Louis University, recently resigned as executive vice president of Rinehart Oil News at Dallas, Texas.

J. I. Earl Norton of Jahn-Lamkin Company has been named representative of Oteco products in the district which includes Shreveport, East Texas, Northern Louisiana, Northern Mississippi, and Southern Arkansas. In Great Bend, Kansas, **Ray Arnold** of Manufacturers' Distributors has been named exclusive distributor for all Oteco products.

J. Fred Hedding and **Thomas A. Collins** were elected to the board of directors of Glass Fibers Inc. Collins, executive vice president and general manager of the glass concern, joined the organization in 1952 and was appointed general manager in 1953. Hedding, engaged in the estate management business in Pittsburgh, is also a director of Diamond Alkali, Broderick and Bascom Rope and Firth Sterling.

Clem W. Kohlman has been appointed advertising manager of the industrial chemicals division of American Cyanamid Company. Kohlman previously directed advertising and sales promotion for the textile resin department of American Cyanamid Company. **A. M. Asherman** will be assistant advertising manager of the division.

Austin Goodyear, general manager of the rubber and conveyors divisions of Hewitt-Robins, Inc., has been elected a vice president of the company. Goodyear joined Hewitt-Robins in 1941 and was appointed production manager of the company's Passaic, New Jersey, plant six years later.

Charles E. St. Thomas has been named manager—advertising and sales promotion at the Carboloy department of General Electric Company. St. Thomas had been news bureau manager since August 1952.

Virgil C. Reed has been appointed field representative for the Southeastern and Southwestern states by the Alloy Rods Company. Reed attended the University of Houston and has had wide experience in the engineering and sale-aspects of the welding industry.

Davis D. Bovaird of the Bovaird Supply Company, Tulsa, newly elected president of the Petroleum Equipment Suppliers Association, has been named to the National Petroleum Council. Bovaird replaces on the council Mason B. Jones of the S. M. Jones Company, Toledo, whom he also succeeds as president of the association.

J. C. Merwin has been elected chairman of the board, Chain Belt Company. **L. B.McKnight** was elected to succeed Merwin as president and chief executive officer of the company. Since 1951 McKnight has been executive vice president of the company.

J. D. (Denny) Stewart has been appointed branch manager for the engine division of The National Supply Company, with headquarters in Casper, Wyoming. **Walter E. Garrard** was appointed to succeed Stewart as oil field engineer for the Northwest division. He will also have headquarters in Casper.

William C. Kinder has been named vice president in charge of all Emsco Manufacturing Company sales. For the last 12 years, Kinder has been in charge of manufacturing and sales of the D-B Division of Emsco, and three years ago transferred from Los Angles to Garland, Texas.

A. N. Cave has joined the sales-engineering staff of Ensign Carburetor Company at its Chicago headquarters. Cave is a graduate of Purdue University. His work with Ensign will gradually develop into a position of sales and service, covering the eastern and Mid-Western states.

H. E. Schall has been promoted to controller and assistant treasurer and **I. J. Newell** to assistant controller and cost supervisor of Glass Fibers Inc. Schall had been with Glass Fibers Inc., three years.

Douglas M. Jones formerly assistant chief engineer and technical consultant, has been appointed chief engineer of Axelson Manufacturing Company, division of Pressed Steel Car Company, Inc. Jones succeeds **Glynn H. Williams** who has been advanced to a special production engineering post.

Richard E. Hoierman has been named advertising manager for the machinery division of Dravo Corporation and the Dravo-Doyle Company. Hoierman succeeds **Robert C. Black** who has been transferred to the sales staff of the division's heating department. Since 1950, Hoierman has been assistant to the director of advertising of Cooper-Bessemer Corporation.

HOW LINCOLN'S HIGH DENSITY WELDING CUTS SHOP COSTS

Simplifies, Speeds Welding. With "Manual Lincolnweld", butt and fillet welds are produced two to four times faster than with conventional hand welding. That's because "Manual Lincolnweld" concentrates up to 600 amps on a small diameter electrode . . . the equivalent of 10,000 amps on a conventional ¼" coated electrode.

Eliminates Joint Preparation. Concentrating high currents produces deeper penetration . . . there is less chance for distortion. Actually a 100% butt weld can be made on ¾" plate with one pass from each side. Thus "Manual Lincolnweld's" fast, efficient welding cuts fabrication time on countless piping jobs for refinery construction and maintenance.

Simple to Use. Less training is needed with "Manual Lincolnweld". That's because the continuous electrode is fed automatically beneath a layer of granular flux for low cost hidden arc welding.

Start Cutting Costs Today. Learn how to save manhours, produce higher quality welds in your shop at less cost with "Manual Lincolnweld".

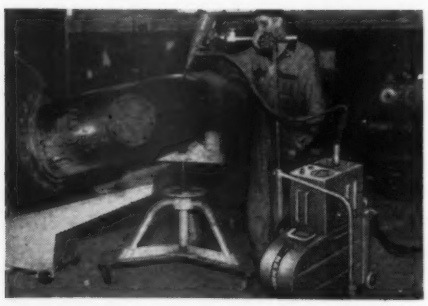


Fig. 1. Fabricated Pipe Fittings. *Welding gun of "Manual Lincolnweld" is mounted in simple fixture and work is rotated with power rolls. Takes only 1½ minutes to complete pressure tight joint on 12" fitting.*

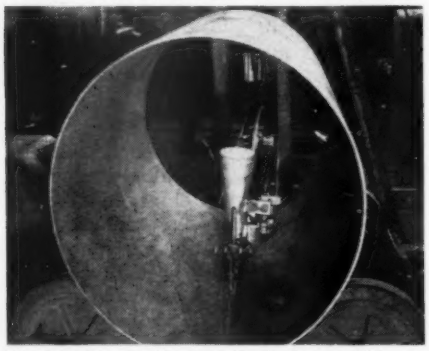


Fig. 2. Fabricates Pressure Tank. *Compact "Manual Lincolnweld" is mounted on elevator-type fixture to position welding gun to work. Welds are uniform, self-cleaning . . . cost less than with hand welding.*

Write Dept. 2809 for details in free descriptive Bulletin 1303.

THE LINCOLN ELECTRIC COMPANY
Cleveland 17, Ohio

THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

Trade Personals

Tucker

Loudenback

Kirberger

Smithey

J. T. (Tommy) Tucker, until recently general manager of sales of Emsco Manufacturing Company, has joined Unit Rig and Equipment Company, Tulsa, as general manager of sales. Tucker joined Emsco in 1940, first as a field service man and later as sales manager of the Mid-Continent operations with headquarters in Houston.

Working with Tucker will be **Ray Loudenback** who has been associated with Unit Rig since 1937. He will serve as Southern division sales manager.

Earl Kirberger, formerly with Franks Manufacturing Company, and in Unit Rig's sales and service department since 1940, will be Northern division sales manager working out of the Tulsa, Oklahoma, office.

Also in the Tulsa office, serving as manager of sales order department, will be **Roy Smithey** who joined Unit Rig in 1949 after several years with National Supply Company.

Norman K. Andrew, chief engineer for Johnston Testers, Inc., has moved from Los Angeles to Houston. He has been with Johnston companies since 1939. **H. J. Quintrell** has been appointed superintendent of manufacturing for Johnston Testers, Inc., and will direct the activities of both the Houston and Los Angeles plants. **T. L. Long** has been promoted by Johnston Testers, Inc., to manager of perforating.

J. L. Barnett, Jr., has been named district manager for the West Texas-New Mexico operations of Baash-Ross Tool Company. Barnett replaces **L. L. (Red) Carren** who was recently named manager of the plant in Canton, Ohio.

Thomas Ray, Jr., has been named sales representative to handle the company's sales operations in northeastern Oklahoma and southern Kansas. Ray will have his office in Tulsa, Oklahoma, where he replaces **P. R. Nagle,** who was recently moved to New York as assistant manager of Baash-Ross Export Operations.

E. D. West has been named general sales manager of Eversharp, Inc., Climax Engine and Pump Manufacturing Division, with headquarters in Chicago. He has been with Climax 19 years.

Fred W. Neubauer who has been with Climax for 35 years, has been appointed plant manager of its Climax Manufacturing Division at Clinton, Iowa. **Ted Skeen,** district manager with headquarters in Dallas, Texas will be in charge of sales and service throughout the Mid-Continent area.

E. J. Anselman, the former general manager, has resigned.

P. Z. Hilliard has been promoted to director of purchases for Mid-Continent Supply Company. Prior to his promotion, Hilliard served Mid-Continent as management coordinator in the Fort Worth offices.

Frank John has been named director of credits for Mid-Continent Supply. John's new duties were assumed on his return from Washington, D. C., where he headed Mid-Continent's office established there in 1951.

H. W. (Robbie) Robinson has been named new manager of stores for Bethlehem Supply Company. Robinson replaces **M. A. (Max) Klepfer** who has been assigned special sales work for the company. Robinson has served the company in every one of Bethelehem Supply's California stores since he joined the company following his graduation from UCLA in 1934.

John J. Neale, formerly Lane-Wells Gulf Coast division manager, has been made assistant to the president. A graduate of Texas A & M, he began work with Lane-Wells in 1936 as a loader. He was formerly Gulf Coast division manager, directing the activities of that division and 40 branches in that area.

Joseph M. Henderson, formerly assistant Gulf Coast division manager, was advanced to Gulf Coast division manager. Henderson, a Texas A & M graduate also joined Lane-Wells in 1936.

G. F. (Bill) Graham has been named assistant sales manager to **Roy A. Dunbar,** general sales manager, oil well

C. F. Graham

D. E. Harder

plunger pump division, Pacific Pumps, Inc. Graham will make his headquarters at Huntington Park, California.

D. E. (Fuzz) Harder will succeed Graham as Mid-Continent manager. Harder has been with the oil well plunger pump division for 20 years.

XUM

New Machinery and Supplies

Use reply card to procure promptly complete information and prices of products described here in brief.

Circle corresponding letter or letters on reply card

(A) PIPETTE

A new pipette with a built-in constriction designed to facilitate use of the conventional cotton plug for the protection of both laboratory workers and the solu-

tions and cultures with which they work, has been developed by the Kimble Glass Company, a subsidiary of Owens-Illinois Glass Company. Based on a suggestion by Dr. H. Gilbert Crecelius, director of laboratories of the Arizona State Department of Health, the constriction is placed near the mouth-end of the pipette. Although large enough for easy cleaning, the constriction permits use of the cotton plug without risk of it slipping into the body of the pipette.

Circle letter (A) on reply card.

(B) AUTOMATIC RECORDING

An instrument for the automatic, continuous recording of concentrations of oxidizable sulfur compounds such as H_2S, SO_2, mercaptans, thioethers, and organic disulfides in gas streams—the Consolidated Engineering Corporation TITRILOG—is now available for lease or sale. The TITRILOG monitors and records sulfur compounds such as hydrogen sulfide, sulfur dioxide.

Circle letter (B) on reply card.

(C) GRIP FLASK

Recently developed are new Kjeldahl flasks. Made with a special "Kool-Grip," they are reported to insure maximum safety and comfort in handling hot acids used in digestions and distillations. This new grip consists of a tough, resilient layer of ground cork securely cemented to the glass with a plastic binder. It extends for a distance of 4½ in. along the tapered neck of the flask, providing full protection to the entire hand when handling hot or cold flasks. They are made by Central Scientific Company.

Circle letter (C) on reply card.

(D) HEAT INSULATIONS

Hydrous calcium silicate pipe and block insulations for high temperature ranges are being used in an increasing variety of industrial applications, according to Owens-Corning Fiberglas Corporation, distributor of the products. Effective to temperatures of 1200 F, the pipe and block, known as Kaylo heat insulations, are used as industrial insulation.

Kaylo heat insulation is made of a chemical compound of lime and silica developed by Owens-Illinois Glass Company, its manufacturer.

Circle letter (D) on reply card.

(E) TEMPERATURE CONTROLLERS

Bristol electronic dynamaster recording potentiometers are now available in the form of time-temperature program controllers, according to an announcement by The Bristol Company. These new program controllers regulate temperature according to a predetermined schedule of changing values. Any desired program, such as a heating, soaking, and cooling cycle can be accurately maintained. Desired schedule of temperatures is prescribed by the contour of a transparent plastic cam.

Circle letter (E) on reply card.

(F) TURBO-SUPERCHARGED ENGINE

Hercules Motors Corporation is now producing a turbo-supercharged version of their 6 cylinder diesel engine Model DFXE. The new engine designated, DFXE-TS, has a 5⅝-in. bore by 6-in. stroke and 895 cu in. piston displacement. The DFXE-TS develops 846 lb ft torque @ 1800 rpm and 318 hp @ 2000 rpm. Engineering features include: Forced feed lubrication by gear pump, 7-bearing, counterbalanced, Tocco hardened crankshaft, high alloy steel valves with valve rotators, etc.

Circle letter (F) on reply card.

(G) CABLE REEL

A cable reel for dozer use, designed to eliminate wastage of large quantities of wire rope due to the wearing out of small sections, is announced by Le-Tourneau-Westinghouse Company. Called the Tournarope bantam reel, its installation on a tractor is simple. This 14-in. reel, which holds 150 ft of ½-in. Tournarope, is designed as a storage reel and is equipped with a bracket that can be welded or bolted on a tractor.

Circle letter (G) on reply card.

(H) SAFETY CARRIER

The Dynascope Company safety carrier and pumping control, Style "B," incorporates a polished-rod carrier for universal application to all rod type pumping wells. Hydraulically operated accessories are employed for safety servicing when maneuvering or adjusting rods, "spacing" or "bumping" valves. Simultaneously or when pumping, the polished-rod load is automatically weighed and recorded.

Controlled micro-settings in "spac-

ing" may be made, tested, changed, or compared progressively with the well in continuous operation at constant or various pumping speeds, and under the constant guidance of the load indicator or recorder.

Circle letter (H) on reply card.

The vise that's a handy portable workbench

RIDGID

New No. 40 Tristand Pipe Vise

Easily taken to the job—legs fold in and chain for carrying, tray quickly on and off. Roomy top has pipe rest and efficient benders; tray keeps tools handy—and also makes Tristand extra rigid, won't fold up in use! Tool-steel Longrip jaws—firm grip but easy on polished pipe and tubing. Yoke No. 40, (old TSY-2½) 2½"; chain No. 45 (old TSC-4) 4". Buy these handy worksavers at your Supply House.

THE RIDGE TOOL COMPANY • ELYRIA, OHIO • U. S. A.

RIDGID
Work-Saver Pipe Tools

New Equipment

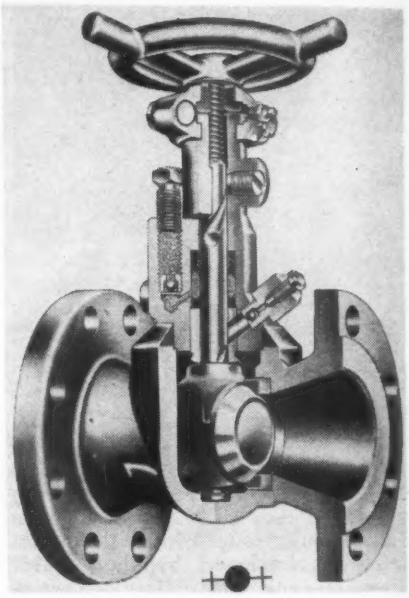
(I) CRAWLER BACK HOE

A new crawler back hoe making its appearance at the recent International Petroleum Exposition, Tulsa, Oklahoma, was the Schield BANTAM ⅜-yd, 5-ton Model C-35. The new crawler model features independent travel, extra long undercarriage, extremely low ground bearing pressure, and 2-speed travel in forward and reverse. As with the T-35 truck-mounted BANTAM, the C-35 crawler model works with any of eight fast-change front end attachments, from crane to back hoe to handle a wide variety of jobs.

Circle letter (I) on reply card.

(J) VENTURI VALVE

For LP gas use, Orbit Valve Company's Venturi valve is designed so that there are no voids in the body to trap fluids, the company reports. Vapor leaks



are eliminated due to welding the forged steel body and bonnet into one, strong pressure vessel. In the ASA class, Orbit Venturi valves are available with flanged end only; carbon trim and stainless trim; and ring joint and raised face. All have maximum ratings of 250 F temperature.

One Orbit valve construction principle is the adjustable plastic stem packing. The stem packing chamber is backed up by a supply of auxiliary packing as extra protection against leakage.

Circle letter (J) on reply card.

(K) WATER SOFTENER

Unique design of the world's largest hot-process hot-zeolite water softener, installed at the Bayway refinery of the Esso Standard Oil Company. This unit was designed and built by Graver Water Conditioning Company, and handles 200,000 gph of feedwater for 650 psi boilers. It is known as the "Sphericone" because its shape combines a sphere and cone, and is 60 ft high and 43½ ft in diameter. Its special shape provides distinctive advantages in obtaining clearer and softer water.

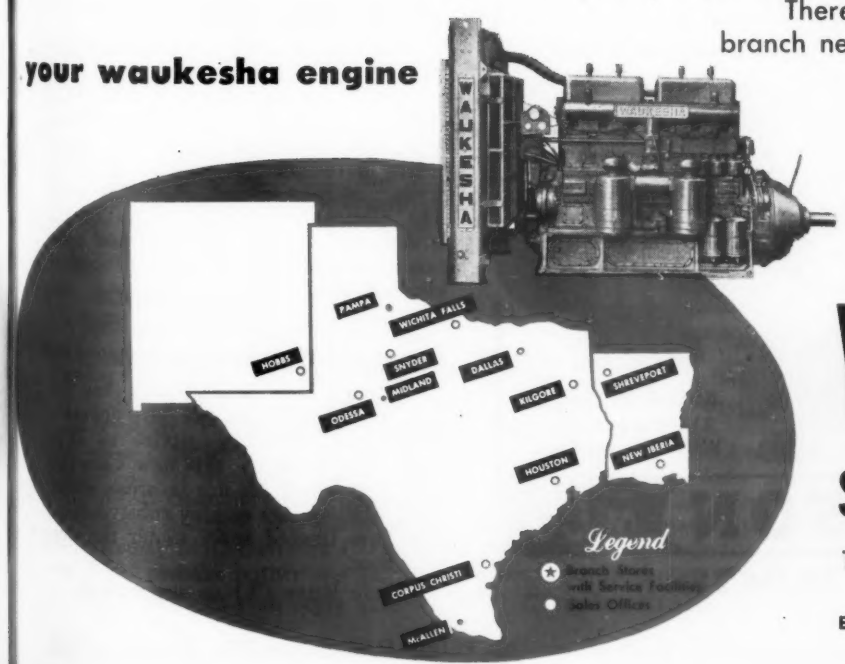
Circle letter (K) on reply card.

there's NO END

TO THE SERVICE AVAILABLE AT WAUKESHA SALES & SERVICE, INC.

From sun-up to sun-up . . . right around the clock . . . your nearby Waukesha Sales and Service, Inc., service shop is ready to give prompt attention to your repair needs. Each branch is staffed with experienced, factory-trained mechanics who ***know*** your engine and how to keep it in tip-top condition at lowest cost. So the next time your engine needs servicing . . . bring it back home. There is a Waukesha Sales and Service, Inc., branch near your operations in Texas, Louisiana, Southern Arkansas, and New Mexico.

your waukesha engine



is treated best at home

WAUKESHA

Sales & Service, Inc.

1422 MAURY ST. • HOUSTON, TEXAS

EXCLUSIVE DISTRIBUTORS FOR WAUKESHA PRODUCTS IN TEXAS, LOUISIANA AND NEW MEXICO

New Equipment

(L) RUBBER LINING PROCESS

The Houston plant of Goodall Rubber Company of Texas have announced the latest development in their rubber lining process. It is a specialized method of molding soft or hard natural rubber, neoprene or other compounds to the flange ends and inner flow surface of metal pipes to be used for conveying chemicals and other solutions requiring protection against corrosion, abrasion, or contamination.

Circle letter (L) on reply card.

(M) METERING PUMPS

CC Pump Manufacturing Division has reported a new controlled volume or metering pump, which is reported to deliver exact quantities of an extremely wide range of products regardless of change in discharge pressures. Liquids can be delivered in quantities as low as 3 ml per hour to as high as 50 gal per minute against pressures to 20,000 psi. Pumps are made of brass, nickel, 18-8 stainless steel, plastic, or any material to meet the need.

Circle letter (M) on reply card.

(N) CASE TRACTORS

A new low cost grader, engineered for Case SI or DI tractors has just been announced by the M-B Corporation. Built along the lines of larger motor graders, this handy, compact unit will handle most any grading and all maintenance jobs, with only a modest initial investment. The M-B grader is specifically designed for either the Case SI or DI tractor and may be attached or removed in less than an hour, leaving the tractor available for other jobs.

Circle letter (N) on reply card.

(O) METER PENS

For use on American Meter Company recording instruments and other makes of meters, Cannon (formerly Chartomatic) meter pens drastically reduce reinking chores—recording for periods up to a year with only one filling and virtually no attention. Clear cut, distinct, uniform lines, contributing to a high degree of accuracy, are produced by the controlled flow of the precision pens. Pulsating flow, rapid pen movement, and atmospheric fluctuations have no effect and chances for error are lessened.

Circle letter (O) on reply card.

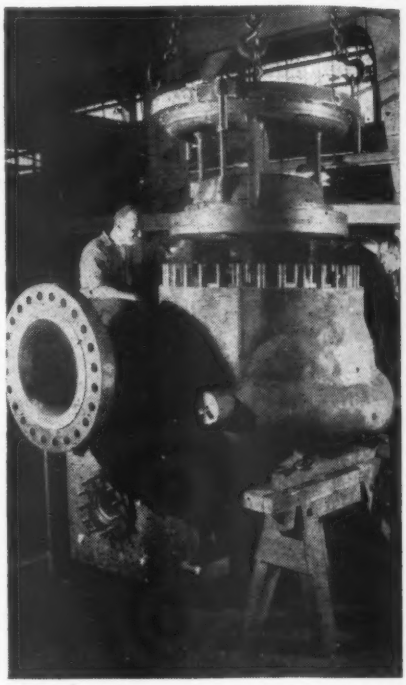
(P) THICKENING AGENT

Attapulgus Minerals and Chemicals Corporation announces the availability of a new thickening agent for making high-quality multi-purpose greases. Called Permagel, product is an entirely inorganic purified colloidal form of the mineral attapulgite. Claimed for its strong, needle-like particle structure (and confirmed by field tests) is the ability to yield lubricating greases with such qualities as: Low temperature pumpability, no melting or dropping points, physical stability, good water washing resistance, etc.

Circle letter (P) on reply card.

(Q) CENTRIFUGAL COMPRESSOR

Recently completed is a centrifugal compressor pioneered by De Laval Steam Turbine Company. It will be



shipped to Texas Eastern Transmission Corporation for installation with other De Laval turbine-driven centrifugal compressors in Texas Eastern's 30-in. gas pipe line running from Kosciusko, Mississippi, to Uniontown, Pa.

Circle letter (Q) on reply card.

(R) SPECTROPHOTOMETER

A recording spectrophotometer which automatically runs more samples in one hour than an operator could all day highlighted the Beckman Instruments, Inc., exhibit at the Eighth National Instrument Society of America Show in Chicago last month. Visitors saw the new Beckman spectrophotometer in full operation, automatically plotting measurements on three samples at once.

Circle letter (R) on reply card.

(S) WELDING HEAD

A new and vastly improved Model 944 automating welding head has been placed on the market by the Mir-O-Col Alloy Company. Control of both welding head and positioner operation is automatic in the 944, as well as the high frequency pilot circuit, if one is used. The electro-mechanical control circuit is designed to stop both head and positioner automatically if arc is broken or electrode sticks to the work piece.

Circle letter (S) on reply card.

(T) BLOWOUT PREVENTER

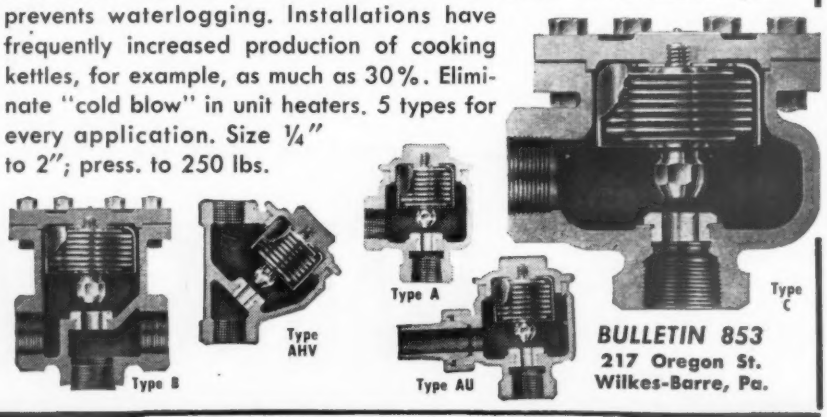
Cameron Iron Works, Inc. has announced a new type pressure-operated blowout preventer. Designated as Type "SS" (space saver), this new Cameron unit is designed for use in areas where many drilling rigs employ substructures that have limited space under the derrick floor.

Circle letter (T) on reply card.

Nicholson Steam Traps Require

NO CHANGE of VALVE or SEAT, 0 to 250 Lbs.

Nicholson steam traps save the time and trouble of adjusting valves for varying pressures. This feature substantially speeds production and maintenance. Made of hardened stainless steel, the valve is extra large, resulting in from 2 to 6 times average drainage capacity. Both valve and seat are renewable. The fast action of Nicholson traps prevents waterlogging. Installations have frequently increased production of cooking kettles, for example, as much as 30%. Eliminate "cold blow" in unit heaters. 5 types for every application. Size ¼" to 2"; press. to 250 lbs.



BULLETIN 853
217 Oregon St.
Wilkes-Barre, Pa.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

Trade Literature

Publication will be sent free.

(U) DUDLEY V-9 PUMP

Eastman Pacific Company has published a sheet describing its Dudley V-9 pump, Model 100. The Dudley V-9 pump is a small light weight pump capable of meeting a wide range of volume and pressure requirements that heretofore necessitated a variety of pump sizes. This model is reported to deliver from 2.4 gpm to 7.2 gpm at pressures from 9 psi to 433 psi.

Circle letter (U) on reply card.

(V) SEPARATORS, EXTRACTORS

A new four-page Bulletin No. 15 is being distributed by Otto H. York Company, Inc. It completely describes through illustrations and text how these entrainment separators and mist eliminators for improving the performance of vacuum towers, distillation equipment, gas absorbers, scrubbers, separators, evaporators, knock-out drums, etc, are constructed—how they work and how they are applied.

Circle letter (V) on reply card.

(W) OIL CLARIFIER

The J-B Engineering Company announces a new brochure describing the development of an oil-heat-exchanger and oil-clarifier as a combined integral unit, which has from both an engineering standpoint and the viewpoint of the operator-owner met with considerable success in preventing many of the undesirable mechanical conditions as are now encountered by the operators of diesel-powered equipment.

Circle letter (W) on reply card.

(X) METAL HOSE

An illustrated eight page catalog covering Chicago metal hose and Flexon expansion joints used in the oil industry has just been released by Flexonics Corporation. This catalog outlines specific usage of Chicago metal hose types in petroleum processing and handling, gas furnace connections, tank settling connections, etc.

Circle letter (X) on reply card.

(Y) BOILER-BURNER UNIT

A new pressurized boiler-burner unit has been developed for high or low pressure heating, power, and process steam and is described in a new 14-page, 6-color brochure. The unit, sold and serviced as a completely packaged plant, represents the work of two separate companies—Titusville Iron Works Company, who designed the boiler; and Iron Fireman Manufacturing Company, who developed the burner system.

Circle letter (Y) on reply card.

(Z) SCALES, BALANCES

Bulletin 15C, recently revised and reissued by Central Scientific Company, illustrates and describes the company's complete line of scales, balances, weights, and accessories. Included are trip scales; general laboratory balances; analytical, torsion, spring, specific gravity, and special purpose balances.

Circle letter (Z) on reply card.

(AA) WIRELON ROPES

An unusual type of booklet describing the properties and qualities of "Wirelon" ropes has just been published by Rochester Ropes, Inc. Constructed of high tensile steel strands and tough, durable nylon, Wirelon has a high strength steel core of 250,000 psi tensile. A hard jacket of transparent nylon protects the core from corrosion and increases fatigue resistance up to five times.

Circle letter (AA) on reply card.

(AB) FLUID DRIVE

American Blower announces the release of a new 2-color, 24-page bulletin covering the Type VS, Class 4 Gyrol fluid drive. Its attractive and unique design permits quick, easy reading and covers such subjects as applications, advantages, features, selection, and dimensions. This bulletin will be of value to engineers interested in obtaining adjustable speed operation in a range from 100 to 2500 hp.

Circle letter (AB) on reply card.

(AC) GAGING TAPES

A new folder, "The Care and Use of Oil Gaging Tapes," published by the Lufkin Rule Company, tells how to get the most accurate readings and the longest service from a gaging tape. The gaging diagram for conventional tanks is illustrated, along with innage and outage bobs, and "Atlas" gaging tapes. The folder is handy pocket-size, and is printed on heavy index stock so that it will last under continual handling.

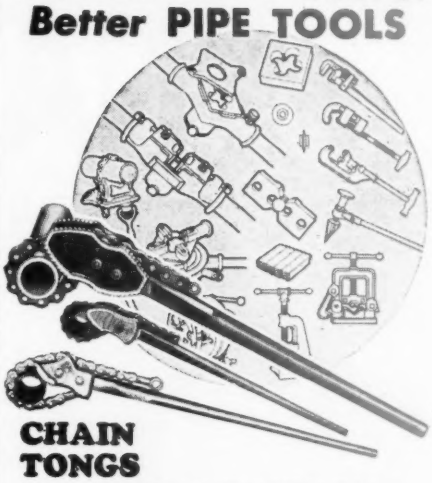
Circle letter (AC) on reply card.

(AD) CRESCENT VALVES

Barksdale Valves has published an 8-page bulletin on Crescent 4-way valves. The valves are solenoid operated and pilot controlled. The 1046 series valves are tight sealing 4-way valves intended for the control of double-acting cylinders. When one cylinder is open to *Inlet* and closed to *Exhaust*, the other is closed to *Inlet* and open to *Exhaust*. Bodies are cast bronze, full ported, with screwed pipe connections. Internal parts, including main valve members, are brass.

Circle letter (AD) on reply card.

ARMSTRONG BROS.
Better PIPE TOOLS



CHAIN TONGS

"Reversible," "Standard" and "Ideal" types in all sizes. Jaws are drop forged from special steel, are carefully milled, heat treated, hardened and tested. The *Handles* are forged spring steel. The *Chains* are proof-tested to ⅔ catalog strength (1,200 lb. to 40,000 lb.). "Reversible" Jaws give double jaw life. "Standard" Jaws have extra bearing on the handle and forged-in chain guides. The "Ideal" Tongs have V shaped teeth for a sure grip on irregular shapes — fittings, etc.

Write for Catalog

ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
5231 W. ARMSTRONG AVENUE • CHICAGO 30, ILL.

"DON'T FENCE US IN!"

The cow, by nature, won't jump the fence . . . The only place we put production fences for ring problems is behind us.

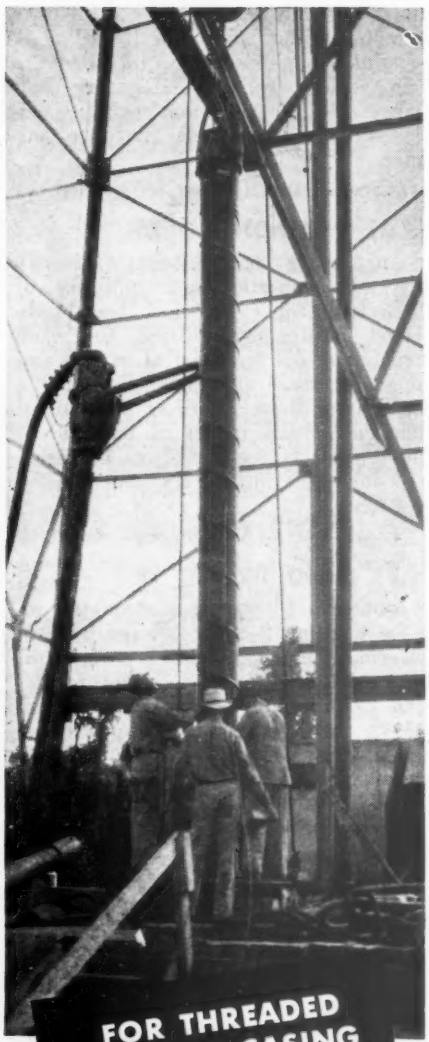
Shirt sleeved engineering in your packing or piston ring problems is something we relish; so "don't fence us in" . . . let us prove to you we can lick your special problems.

Write for Complete Information

- Metallic Packings
- Power Piston Rings
- Carbon-Bakelite Liquid Pump & Compressor Piston Rings
- Valve Discs

FRANCE PACKING COMPANY
6512 STATE RD., PHILADELPHIA 3, PA.

THE DISTINCTIVE SPIRAL TELLS YOU IT'S NAYLOR



FOR LINE PIPE

Naylor gives you extra strength, leaktightness and safety in a light-wall pipe that's easy to handle and install. Sizes from 4 to 30 inches in diameter. Ask for Bulletin No. 507.

FOR THREADED SURFACE CASING

Naylor Casing is threaded to A.P.I. standards. No field welding necessary. No need for centralizers, with Naylor's characteristic spiral. Ask for Bulletin No. 251.

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1240 East 92nd Street, Chicago 19, Illinois
New York Office: 350 Madison Avenue, New York 17, New York

Mid-Continent Supply Company Ft. Worth, Texas and Branches
Exclusive distributors in Mid Continent and Gulf Coast Areas

Trade Literature

(AE) PLUG VALVES

The William Powell Company has announced publication of a new booklet on its lubricated plug valves. The lubricated tapered plug design offers quick shutoff of erosive or corrosive fluids, the company reports. Seating surfaces are not exposed in the open position so that gritty suspensions may readily be handled, and the cavity-free straight line passage assures a streamlined flow.

Circle letter (AE) on reply card.

(AF) CONTROL IN WATER

Milton Roy Company has reissued technical bulletin No. 55 on "Automatic pH Control in Water and Industrial Waste Treatment." This is a reprint of a paper delivered by R. T. Sheen, president of the company. Outlined are several typical systems of automatic pH control in boiler feed water treatment, using air—and motor—operated valves.

Circle letter (AF) on reply card.

(AG) INDUSTRIAL GLOVES

Wicx Safety Gloves Company has published a four-page brochure illustrating and describing its various products. Illustrated are its welding mitts, welding gloves, seamless mitt with fleece lining for welding and also flexible gloves that protects against heat.

Circle letter (AG) on reply card.

(AH) MECHANICAL SEAL FILM

Byron Jackson Company has published a 16-page bulletin on its mechanical seal motion picture. The bulletin is fully illustrated with line drawings of balanced and unbalanced seals, single seals, seal faces, drive collar being installed, seal cover and stationary face, etc. The film may be obtained for rental from Byron Jackson.

Circle letter (AH) on reply card.

(AI) PUMP, GEAR DRIVE

Johnson Gear and Manufacturing Company, Ltd., has announced publication of two new bulletins. One is on the Johnson turbine pump drive and the other on its solid shaft gear drive. They are catalogues No. 22 and 24, and are completely illustrated. Both catalogs contain line drawings and data sheets.

Circle letter (AI) on reply card.

(AJ) RADIOGRAPHY

The Andrex portable X-ray units for industrial radiography are discussed in a new bulletin recently published. Thoroughly illustrated, the new bulletin contains many specifications, and describes some of the features of the Andrex features, accessories, rubber cassettes, and high definition intensifying screens.

Circle letter (AJ) on reply card.

(AK) PRECISION BALLS

Coolidge Corporation has published a 4-page brochure on its precision chrome alloy and stainless steel balls. The company reports that all balls are produced by either the cold up-set or hot forging method, depending on size.

Circle letter (AK) on reply card.

Trade Literature

(AL) VALVE ACTUATORS

Ledeen Manufacturing Company has announced a 2-color, 4-page bulletin on valve actuators. The new bulletin illustrates and describes the gage valve actuator, plug valve actuator, tandem and unit types, and actuator selection. On the back page are three tables giving the capacity of gage and diaphragm valves actuating cylinders in pounds, torque ratings of tandem type plug valve actuators in inch pounds, and torque ratings of unit type plug valve actuators in inch pounds.

Circle letter (AL) on reply card.

(AM) STEAM JET EVACTORS

Croll-Reynolds Company, Inc., has published an 18-page bulletin on its vacuum ejectors and condensers. The bulletin is completely illustrated. It describes the various size steam jet evactors and their advantages over mechanical vacuum pumps. At the present time Croll-Reynolds has in operation five-stage units that not only operate in the micron range but handle much larger loads than mechanical vacuum pumps.

Circle letter (AM) on reply card.

(AN) WIRE ROPE SLINGS

McWhyte Company has published a four-page brochure on its Atlas round-braided wire rope slings. It is profusely illustrated and shows and describes many examples of where the wire rope slings have been used successfully. Flexibility of Atlas braided slings is obtained by: Ropes are spliced endless before braiding; right lay ropes balance left lay ropes, and all ropes follow uniform spiral paths, assuring balanced tension throughout the sling body.

Circle letter (AN) on reply card.

(AO) STEAM TURBINE

High speed steam turbines for centrifugal compressor and blower drives are the subject of Bulletin No. 1966-536-BP now offered by Worthington Corporation. The bulletin describes manufacturing and engineering features of the turbines including four types of governing arrangements, hand and automatic nozzle controls, and other controls.

Circle letter (AO) on reply card.

(AP) SEAMLESS PIPE

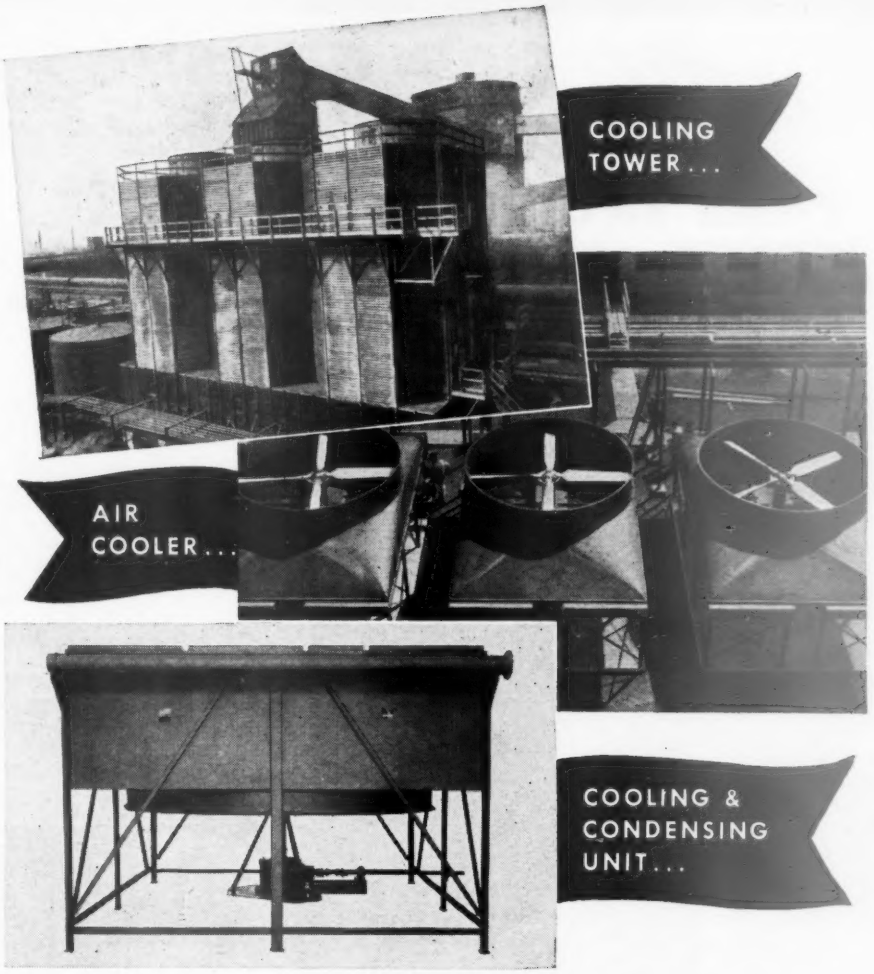
Republic Steel announces its entry into the production of oil country seamless casing and tubing in a new 24-page, two-color, 8½ × 11 catalog titled "Republic Seamless Oil Country Tubular Products." Included are an aerial view of the new plant, a map showing the strategic location

Circle letter (AP) on reply card.

(AQ) SCRAPERS

A new line of open-top, tractor-drawn rubber-tired scrapers ranging in capacity from 10.5 to 28.5 cu yd is announced by LeTourneau-Westinghouse Company. These scrapers are designed to fit any tractor-scraper job and are available in four sizes.

Circle letter (AQ) on reply card.



Whatever the installation, it pays you to Specify Aeromaster Fans

Practically every manufacturer of cooling units in this country has used Aeromaster Fans as original equipment! There are many reasons for this choice. Aeromaster Fans are an adaptation of high-speed aircraft propellers—precisely prebalanced, with an easily adjustable blade pitch to meet changing power requirements. They give you top efficiency and improved anti-flutter performance . . . require less horsepower to operate.

Aeromaster blades are protected against mild acids and alkalies, abrasion, all weather conditions, by a special *Aeroloid* blade coating, exclusive with Aeromaster. Aeromaster Fans are fully guaranteed . . . many models, ranging from 5 to 24 ft. diameters, with 4, 6, or 8 blades per fan—capacities up to 1,000,000 cfm. As original equipment or for replacement, Aeromaster Fans are tops for long-lasting, reliable operation at less cost!

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This Koppers Division also supplies industry with Fast's Couplings, American Hammered Industrial Piston and Sealing Rings, Koppers-Elex Electrostatic Precipitators and Gas Apparatus. *Engineered* Products Sold with *Service*

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Name _____
Title _____ Company _____
City _____ Zone _____ State _____

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National

TANK ENGINEERS SOLVE CRUDE HEATING PROBLEMS IN LEDUC FIELD

SOUTH LEDUC—4' x 27½' "YCP" 15# National Treater

LEDUC—4 Hi-500 Bbl. National Bolted Steel Tanks

1 6' x 20' "YIWP" 15# National Treater

1 2C, 2½' x 13' 125# National Separator

1 NC, 2' x 6' 125# National Separator

Instead of expensive boiler installations, many Canadian operators are turning to National Treaters to maintain crude pour point under extreme weather conditions. Temperatures as low as 60° below zero, inadequate water supplies, frequent shut-downs, oil loss through steam heat evaporation were the difficulties that led National engineers to a practical and economical solution.

By re-designing piping hook-ups and circulation lines, by putting crude in at the bottom of the tanks and by installing a National Treater instead of a boiler, all difficulties of maintaining pour point have been eliminated. Crude is circulated from tanks through treaters. Unlike boilers, National Treaters require very little water.

They can be shut down for several days without draining without fear of freeze-up. If a longer shut-down is necessary, water can be drained quickly. Refilling to go back into operation can be done easily and at a minimum cost.

It's a National

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